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Evaluation of the Effectiveness of the German Federal Government with Respect to Sustainable Mobility

Wuppertaler Studienarbeiten
zur nachhaltigen Entwicklung

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Wuppertaler Studienarbeiten zur nachhaltigen Entwicklung

Das Wuppertal Institut für Klima, Umwelt, Energie erforscht und entwickelt Leitbilder, Strategien und Instrumente für Übergänge zu einer nachhaltigen Entwicklung auf regionaler, nationaler und internationaler Ebene. Im Zentrum stehen Ressourcen-, Klima- und Energieherausforderungen in ihren Wechselwirkungen mit Wirtschaft und Gesellschaft. Die Analyse und Induzierung von Innovationen zur Entkopplung von Naturverbrauch und Wohlstandsentwicklung bilden einen Schwerpunkt seiner Forschung.

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Das Wuppertal Institut versteht die Veröffentlichung als wissenschaftliche Vertiefung des gesellschaftlichen Diskurses um den Übergang in eine nachhaltige Wirtschafts- und Lebensweise.

Vorwort

Verkehr ist zentraler Bestandteil diverser Lebensbereiche. Sowohl für die wirtschaftliche Entwicklung eines Landes als auch für die Teilhabe am gesellschaftlichen Leben und die persönliche Entfaltung sind Mobilität und deren Realisierung durch Verkehr unerlässlich. Gleichzeitig verursacht der motorisierte Verkehr massive Belastungen für Mensch und Umwelt.

Die Verkehrspolitik steht vor der großen Herausforderung, die richtigen Weichen zu stellen, um ein gesellschaftlich akzeptiertes Verkehrssystem zu gestalten, das ökologisch verträglich, wirtschaftlich effizient und sozial gerecht ist. Da es hierfür keine Patentlösungen gibt, erfordern politische Strategien, Maßnahmen und Instrumente eine integrierte Herangehensweise auf allen Handlungs- und Entscheidungsebenen unter Berücksichtigung der spezifischen politischen und gesellschaftlichen Zielsetzungen sowie der räumlichen und finanziellen Rahmenbedingungen.

Die vorliegende Masterarbeit von Robert Gruber, die an der Universität zu Köln vorgelegt und am Wuppertal Institut betreut wurde, beschreibt und bewertet nun die Politik der Deutschen Bundesregierung bezüglich ihres erklärten Zieles, Mobilität nachhaltiger zu machen. Dabei liegt ein besonderer Augenmerk darauf, inwieweit auch sogenannte „weiche“ Maßnahmen verfolgt werden.

Die Arbeit analysiert die Schwerpunkte einer Effizienzpolitik der Bundesregierung, aber auch die Fördermechanismen des Individualverkehrs sowie Instrumente, die gezielt nicht eingesetzt werden, aber dennoch wichtige Bestandteile einer nachhaltigen Mobilitätspolitik beinhalten könnten. Die Analyse kommt zu dem Schluss, dass Ansätze zur Beeinflussung des individuellen Mobilitätsverhaltens etwa in Form von Kampagnen hingegen kaum Beachtung finden.

Die vorliegende Arbeit macht auf diese Ungleichgewichte aufmerksam und macht deutlich, dass es Politikpakete, die auch weiche Maßnahmen umfassen, bedarf, um Mobilität nachhaltiger zu gestalten.

Die Arbeit wurde von Frau Dr. Wagner an der Universität zu Köln bewertet und als gut strukturierte, dichte Überblicksarbeit in das Thema angesehen. Die gelungene Strukturierung und das fachliche Hintergrundwissen weisen diese Arbeit als sehr gute Studie zur Rolle der Bundesregierung im Hinblick auf nachhaltige Mobilität und Analyse über das deutsche Verkehrssystem im Allgemeinen aus.

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Zusammenfassung

Transport, insbesondere der Straßenpersonenverkehr, verursacht massive Umweltauswirkungen und Treibhausgasemissionen, die bisher nur unzureichend politisch bekämpft wurden. Gerade Deutschland mit seiner starken Automobilindustrie und dem gut ausgebauten Straßennetz ist hier keine Ausnahme.

Diese Arbeit analysiert die regulatorischen, fiskalischen und weichen Maßnahmen (wie Image-Kampagnen) für nachhaltigen Personenlandverkehr der Deutschen Bundesregierung. Sie zeigt die Fixierung auf teure technische Maßnahmen wie Elektromobilität und Infrastrukturausbau, eine Veränderung des Mobilitätsverhaltens wird jedoch nicht angestrebt: Anstatt den Fokus auf Verkehrsvermeidung und Verkehrsverlagerung zu legen, werden rein technische Lösungen für Emissionsprobleme propagiert.

Die vorliegende Arbeit vergleicht die Ziele und Politikpakete der Bundesregierung mit ihren Anstrengungen und den Umweltkennwerten und zeigt, dass eine Transition im Transportsektor notwendig ist, um gerechte, erschwingliche und nachhaltige Mobilität für jeden Deutschen zu erreichen.

Abstract

Transportation is one of the most pressing and least tackled problems for environmental protection and global warming, also in Germany, which is known for its car industry and highways. This thesis analyzes federal legal, fiscal and “soft” measures (such as awareness campaigns) for sustainability in the land transport sector in Germany. It shows the fixation on expensive technical programs such as electric mobility and infrastructure expansion to solve sustainability issues mobility behavior is not attempted to change. Instead of focusing on a traffic avoidance and modal shift, the federal government tries to solve emission problems only by improving engines and technology. The study compares goals and achievements of German politics and political packaging for sustainable transportation and shows that a massive transition in the transport sector is necessary to ensure affordable, socially just and environmentally friendly mobility for everyone.

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Furthermore, I want to give thanks to all my proofreaders and my father for a long Saturday night of formatting.

SDG.

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- **Bundestag:** The German parliament in Berlin
- **Bundesrat:** The assembly of the German the German federal states, called “Länder”
- **UBA:** Umweltbundesamt, the German Environmental Agency
- **BMU:** Bundesministerium für Umwelt und Naturschutz – Federal Ministry for Environmental Protection
- **BMWI:** Bundesministerium für Wirtschaft und Technology – Federal Ministry for Economics and Technology
- **EC / EU / EEC:** European Comission / European Union / European Economic Community
- **UIC:** Union Internationale des Chemins de fer: International Union of Railways
- **CO_2, NOx, VOC´s, SOx, PM, CO, (NM)HC***:* Carbon dioxide, Nitrous oxides, Volatile organic compounds, Sulfur oxides, Particulate matter, Carbon monoxides, (non-methane) Hydrocarbons: Air pollutants and greenhouse gases emitted by transportation
- **VAT:** Value-added tax
- **LPG, CNG:** Liquid petroleum gas, Clean natural gas (car propellants)
- **IEA:** International Energy Agency
- **LRTAP:** The convention on Long-range Transboundary Air Pollution
- **NABU:** Naturschutzbund Deutschland – Confederation for environmental protection Germany
- **Bundesverkehrswegeplan (BVWP):** National Transport Infrastructure Plan
- **EEA:** European Environmental Agency
- **KBA:** Kraftfahrtbundesamt – Federal Motor Transport Authority
- **VCD:** Verkehrsclub Deutschland – German Transport Club

Introduction

Transportation is one of the major sources of harmful air pollutants such as NO_x and sulfur components. Additionally, 15% of all greenhouse gases worldwide originate from transportation activities – and this fraction is growing: Unlike other sectors, greenhouse gas emissions from transportation continue to grow. From 1990 to 2007, transportation emissions grew by 45% (OECD / ITF 2010), which is mainly the result of the enormous transportation growth in the developing countries, especially the BRICS (Brazil, Russia, India, China, South Africa) countries. By 2050, the worldwide vehicle stock is expected to double or even triple (IEA, 2009). The expected energy efficiency improvement for conventional vehicles of 30% by 2050 (IEA, 2011) will not help much to combat this enormous growth. The main share of transportation emissions comes from road transportation: In the EU, 70.9% of the emitted CO_2 in Europe comes from road vehicles (EEA, 2010). This shows that a special focus should be put on road vehicles, especially private cars.

In Germany, transportation is the biggest energy consumer, constituting almost 30% of the primary energy consumption (UBA, 2009f). 18% of the CO_2 emissions (144 Mt) are created by transportation (almost only from road transportation), where the trend toward heavier and more powerful vehicles compensates for energy efficiency improvements. An urgent need for action is visible here, while other emissions such as CO and sulfur components have been successfully decreased.

The problem is far from being solved: Referring to the traffic forecast of the German Federal Republic, the motorization rate will grow from 671 to 737 passenger cars per 1000 inhabitants by 2025 and motorized traffic is expected to increase by almost 18% (after the preceding increase from 140% for passenger traffic and 260% for freight traffic, cf. Figure 1). Meanwhile, the share of public transportation is expected to stagnate or even decline. CO_2 emissions are expected to decrease by 9.2% in total, but 20% are necessary for Germany´s climate goals (UBA, 2007). Aviation emissions, which are especially harmful for the environment (because they emit in high altitudes where the emissions have a higher impact) are on the rise: A growth of 56.2% is projected. Freight traffic will increase by more than a quarter, with high shares of road transportation (IEA, 2009). From this, we can see that measures for the reduction of the carbon footprint of transportation have to be taken.

A major part of the problem is the modal split of the transport modes: In Germany, the share of individual motorized transport is at around 80% while public transit is used for only 15% of the person kilometers. This is a problem because of the different energy consumptions of the transport modes: While passenger vehicles have an energy consumption of 3-4 MJ / passenger kilometer, public transit only uses 0.5-1.5 MJ / passenger kilometer and, accordingly, emit less greenhouse gases.
Non-motorized transport modes such as cycling or walking use no fossil fuels at all and, therefore, cause no greenhouse gas emissions (Kenworthy, 2003, cf. Table 1)

	Unit	Car	Coach	Long distance Rail	Airplane	Bus	Metro	Short distance Rail
CO	g/pkm	1.2	0.05	0.01	0.35	0.16	0.02	0.04
CO_2	g/pkm	138	31	46	356	70	78	77
VOCs	g/pkm	0.14	0.02	0	0.08	0.06	0.01	0.02
NOx	g/pkm	0.29	0.3	0.06	0.55	0.65	0.08	0.29
PM	g/pkm	0.006	0.006	0	0.001	0.008	0	0.003
Gasoline equivalent consumption	l/100 pkm	6	1.4	2.5	5.6	3.1	4.3	4
Avg. load factor		1.5 pers/car	60%	46%	73%	21%	18%	26%

Table 1: Characteristics of certain transport modes, adapted from (UBA, 2008a)

Since different transport modes have very different energy consumptions and the potential for energy efficiency improvements are limited (McKinsey, 2007), technical efficiency improvements alone are not enough – it is also necessary to induce a modal shift from passenger cars to public transportation and non-motorized transport. The question of sustainable transport thus is not only a question of technical standards but also of changing attitudes toward transportation in general.

In this respect, urbanization is a major challenge: Around 50% of the global population – about 3.3 billion people – lives in cities today; and this fraction is growing: By 2030, 5 billion people are expected to live in increasingly growing cities (UN, 2008). Transportation problems such as congestion are already an important problem and the growing energy consumption of passenger cars (1% of the total fuel consumed in Germany is consumed during congestions: VCD, 2006) shows the need for ways to reduce environmental impacts of (urban) transportation and new ways of traffic reducing urban planning.

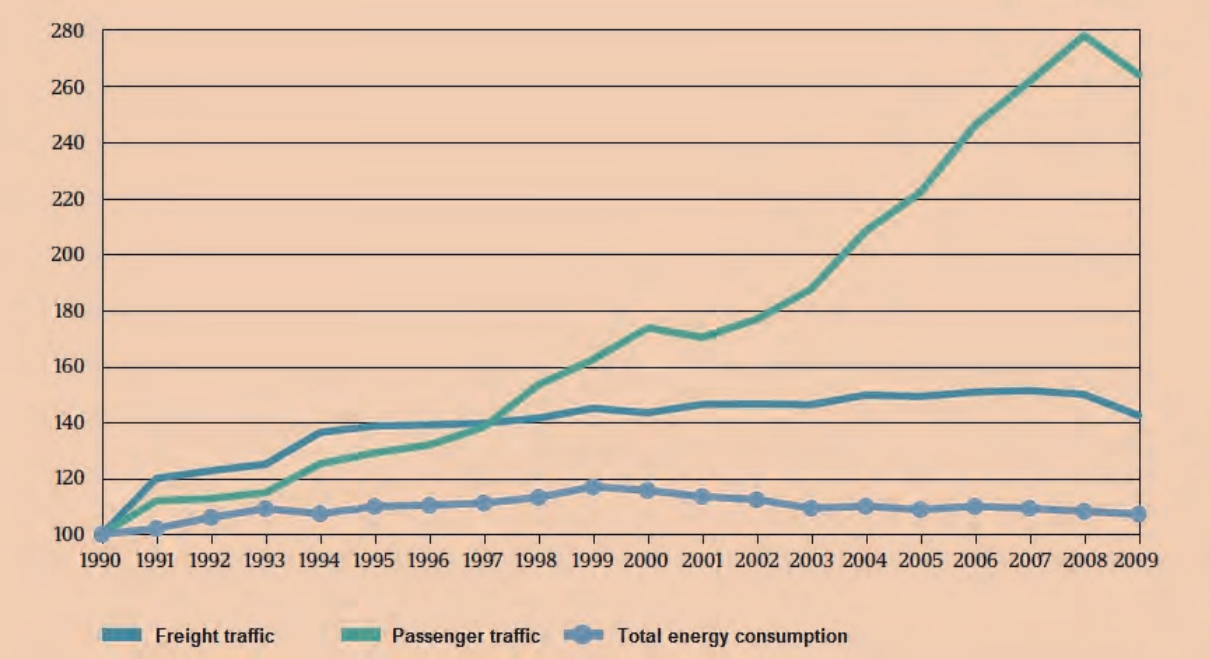

Figure 1: Development of the German transport demand, adapted from BMWI (2010)

It is obvious that transportation is a major source of harmful air pollutant and greenhouse gases – especially in a developing world with accelerating urbanization - and requires higher attention. Consequently, efforts must be taken for the transition of the transport sector into an environmentally friendly provider of mobility (Schneidewind, 2010).

In this master thesis, the effectiveness of the German Federal Government in providing sustainable transportation in Germany is evaluated.

Explaining the term "sustainable transport", a definition of the European Conference of Ministers of Transport (ECMT, 2004) is cited. It states that a sustainable transport system

"a) allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations; b) is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy; and c) limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise."

The focus of this paper is on sustainability as the reduction of the emission of greenhouse gases and harmful air pollutants. Still, transport raises a number of additional sustainability issues that are not covered here: Area and resource consumption, social justice, procurement, noise and more (cf. BSV Office for Urban Planning, 2004). Measures for the reduction of emissions in general have positive side benefits concerning these other sustainability issues, as well.

Furthermore, only the *running* emissions of transportation are considered here. Effects such as recycling, resource extraction and life cycle emissions (non-operational greenhouse gas emissions can amount to 50% or more of the total life cycle emissions: Chester & Horvath, 2009) are not included in this study. To limit the extent of the paper and to be able to perform a deeper analysis, only passenger land transport is considered, as freight transport and sea and air transport are highly influenced by international politics and agreements.

1. Unsustainable Transportation Patterns and how they can be changed

The current efforts to achieve a state of "sustainable transportation" are mainly focused on technical improvements (electrical cars, biofuels). Billions of dollars are spent on research projects for less energy-consuming car propulsion techniques and new high-speed railways. Meanwhile, arable land in second and third world countries is used to grow biofuels for the first world instead of being used to grow food. The patterns of "technology religion" and the dependency of the second and third world on the industrialized countries are maintained and even expanded for the sake of "sustainable transportation". The results, however, are disappointing: As we have seen in the introduction, transportation is becoming more and more unsustainable. The following statement of Button and Nijkamp (1997) stays true for 2011:

"In recent years, many proposals have been made to favor less environmentally damaging transport systems and behavior, ranging though road pricing, technological advances, technical standards, compact city design and land-use policy. The results, thus far, have not been impressive. Although standard economic concepts are clear in that the user and the polluter should pay the full costs of travel, including all externalities, there are many problems with the implementation of such concepts, public acceptability is low and international agreements are difficult to reach."

One of the main reasons for this failure is the widespread disregards of social and psychological aspects of (especially passenger) transportation. As cars are the main source of transport related pollutants and greenhouse gas emissions, two questions must be raised: What are the reasons for unsustainable transportation patterns? And: How can they be changed?

1.1 Social Change and Transportation

Mobility is a social phenomenon. It can be said that mobility is a social need on the same level as communication or the wish for acceptance. There are few worse things that can happen to human beings than being "immobilized", as desires like freedom and independence are associated with mobility. This is and was true for all societies independent of culture, technical progressiveness and values, as a graph by Infas / DLR (2008) shows: Daily travel time seems to be a constant for almost all human beings. We literally need to travel.

This raises a problem: If people have the strong desire to travel, programs to lower travel demand may not be successful. It is not an issue of *if* people travel, but more of *how* and *how far* they travel. This is where technical solutions have proven to be ineffective, as (Black, 2000) describes:

"Although transport is often considered an area of technical and engineering research, this is not true of the problems and changes noted above. (...) Our choices of transport modes and vehicles stem from psychological processes that are not well understood. Our travel patterns are influenced and determined by cultural, social, spatial, behavioral and environmental factors. (...) One could go so far as to say that we have solved nearly all of the scientific and engineering problems of transportation, we must now make these solutions economical and politically acceptable. In other words, it is now time to solve the social science problems of transport."

It is important to include policy, technical solutions, behavioral change and their interfaces in a "sustainable mobility" concept (compare Figure 2). In this study, the focus is on the interplay between policy measures and behavioral approaches to sustainable mobility. Besides the psychological factors that will be analyzed in this chapter, the following social trends have led to patterns of unsustainability in the passenger transport sector (Black, 2000):

- **Decentralization**: While the trend for decentralized cities is more extreme in the US, German cities have also experienced increasing decentralization. Each second, 9.03m² of land are "consumed" (Schröter, 2011), which adds up to 285km² per year (German Statistical Office: GENESIS online). Reasons for this development are the wish for residence outside the crowded and expensive city and the possibility for individual mobility with a private car. This development causes transport demand to increase (because of higher trip lengths) and lowers modal shares for public transportation systems (because of a worse connection to public transport possibilities).
- **Household and population-related changes:** With a trend away from the nuclear family and towards single parent and single households, the total number of residential units and transport movements is increasing rapidly. The wish for personal freedom and their own way of life drives many young people into the cities and generates many trips with the purpose of a family visit. At the same time, Germany´s society is becoming older and, although older people used to have a lower transit demand, the wish for mobility is growing in this age group (Infas / DLR, 2008).
- **Workplace related changes:** The massive entry of women into the labor force and the movement of companies into rural areas and the outskirts of cities (because of cost considerations) have changed commuting mobility significantly. Combined with the fact that people increasingly wish to have a spatial distance between their working place and residence (German Statistical Office, 2009, TU Berlin, 2001), a growth of work-related travel can be observed (German Statistical Office, 2009). Teleworking and the use of ICT technology has not reduced transport demand significantly as of this time (cf. Infas / DLR, 2008).
- **Globalization:** Globalization has dramatically accelerated aviation use and freight transport, but is in two ways also important for the German passenger transport system: Holiday travel through Germany and by German citizens to destinations in Europe has extended since the 1950´s; with motorized individual vehicles conducting most of these trips. Secondly, globalization affects work-related travel and increased the need for passenger travel to destinations in Europe and worldwide, as companies install more and more branch offices in different parts of the world.

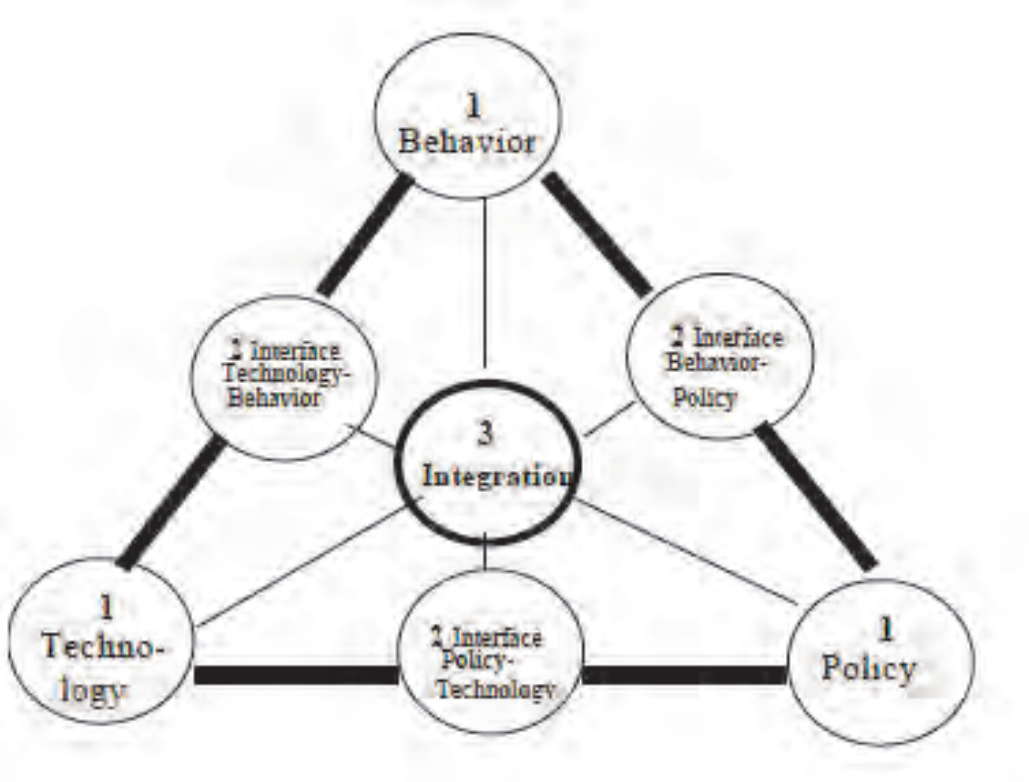

Figure 2: The Triangle for sustainable mobility, source: (Black, 2000)

Although social trends with an influence on transportation clearly exist, mobility in itself is purely individualistic. Group travel has become an exception more than the norm. Consequently, social trends and explanations are not enough to explain the current unsustainable status of the transport system. Psychological behavior theories can fill this gap to a certain extent.

1.2 Psychological Theories of Behavioral Change

Psychological models for the explanation of behavior are, as all models, per definition not 100% correct, as they can only display a limited, ideal section of the real world. Due to the complexity and number of involved factors and the differences among humans, Anable (2005) concludes that

"A realistic analysis, therefore, recognizes both the multiplicity of factors, including psychological variables, and the fact that combinations of factors are different for different people".

Psychological models can, despite of their limitations, help in identifying the key variables for our travel behavior and provide guidance on how to structure measures for sustainable transportation. Most models for behavior change come from clinical psychology and describe a desired change of behavior away from harmful acts such as addictions. In this respect, they are applicable to mobility, as unsustainable mobility is influenced by many similar factors as those described in the three psychological models in the next chapters.

The three main theories for the explanation of behavior and behavioral change are explained in the following chapters, starting with the theory of reasoned action.

1.2.1 The Theory of Reasoned Action

As the first approach to the theoretical explanation of the links between attitudes, norms and behavior, Icek Aizen developed the theory of reasoned action. The behavioral intention for a certain action referring to this theory is determined as the (weighted) sum of two "variables".

1. The attitude of a person towards performing the behavior (their own personal wishes, beliefs and attitudes play into this factor (UBA, 2007)) and
2. The subjective norm related to performing this behavior (the belief of what others, especially experts, think and the wish to comply to others play into this factor).

The behavioral intention (BI) in this theory is "calculated" with

$$BI = (A_B)W_1 + (SN_B)W_2$$

with A_B = The attitude towards the behavior, W_x = Empirically derived weights, SN_B = The subjective norm related to performing the behavior (University of Twente, 2010).
If a person has to decide between two behaviors, he will choose the behavior with the highest rating. To change the behavior of a person, thus, it is not only necessary to change his attitude but also to change the way he thinks how those around him evaluate a behavior, and, respectively, its alternative (ibid.). Although the theory explains behavior as a complicated mixture between the attitudes of a person and the way he perceives others to react to his attitudes and the considered behavior, the theory was criticized as being too simple, as it does not include the strength of a person to carry out the behavior that fits is norms. Icek Aizen hence introduces the concept of "self- efficacy" and expanded the model to the "theory of planned behavior".

1.2.2 Theory of Planned Behavior

The theory of planned behavior has a similar conceptual basis as the theory of reasoned action: If a person has to choose between two alternative behaviors, he will choose the behavior with the highest rating. The rating is, as in the theory of reasoned action, "calculated" as the weighted sum of different factors. As in the theory of reasoned action, the attitude towards the behavior and the (perceived) social norm of the behavior are two of the factors. As the main difference, a third factor, the *perceived behavioral control,* is added. This factor, also called *self-efficacy,* is defined as *"the conviction that one can successfully execute the behavior required to produce the outcomes"* (Baumeister, 1999) and is seen as the most important precondition for behavioral change as it determines to what extent a person can control his own behavior (University of Twente, 2010):
The theory of planned behavior can be expressed as the following function (ibid.):

$$\mathbf{BI = (W1)AB_B + (W2)SN_B + (W3)PBC_B}$$

where BI = Behavioral intention, AB_B = Attitude toward behavior, SN_B = (Perceived) social norm towards the behavior, PBC_B = Perceived Behavioral Control, W_x = Empirically derived weight.

To initiate a behavior change, according to this model, the following steps should be taken:

- Change the attitudes of a person
- Change the social norms concerning a behavior or the person's view of the social norms
- Increase the self-control of a person or the give him the conviction that he can change his behavior

As one of the big weaknesses of the model, the lack of consideration of emotions has to be mentioned. But, especially for car use, emotions play an important role. Nevertheless, the theory of planned behavior can help determining the psychological needs for behavior change. The next model explains the possible ways of behavior change and different steps to achieve it.

1.2.3 The Transtheoretical Model

Developed as a model for health psychology to describe the process of changing unhealthy behaviors such as smoking, the *transtheoretical model* can be adopted to the process of changing unsustainable (and therefore also unhealthy) transportation behaviors such as driving by car.

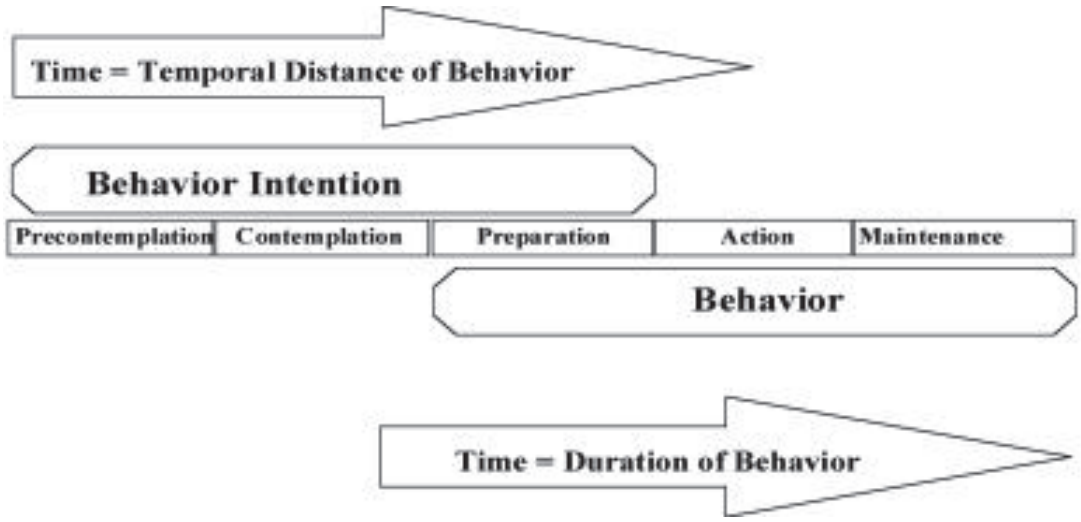

Figure 3: The different steps of behavior change, based on the transtheoretical model, (Cancer Prevention Research Center, 2011)

The transtheoretical model categorizes the attitudes of people towards a certain desired behavior (in this case, the use of more sustainable transport modes) into six categories (cf. Figure 3):

- Precontemplation: A person is not planning to take action on a certain behavior; the current behavioral pattern is most likely not seen as problematic. The behavior in this state can be described as "behavioral procrastination"
- Contemplation: A person recognizes that his current behavior is problematic and begins to evaluate the pros and cons of alternative behavior.
- Preparation: A person plans to take action on the behavior in the near future, small steps towards that goal are happening.
- Action: Overt behavioral modifications are conducted, positive change is achieved.

- Maintenance: The person is working to prevent relapse, "a stage which can last indefinitely" (Cancer Prevention Research Center, 2011).
- Termination: A state of zero temptation and total self-efficacy is achieved; relapse is impossible and positive behavior is maintained.

As a simpler version of the transtheoretical model, the "i-change" model uses only three steps: Awareness ⇨ Motivation ⇨ Action (De Vries, Mesters, van de Steeg, & Honing, 2005)

Behavioral change in the transtheoretical model is not seen as a singular, but rather a process including different steps towards behavior change and – one of the strengths of the model – also aims at maintaining this positive change.

As possible help to ascend to the next "category", the following eight (out of ten original) measure categories were chosen to be relevant for the changing of transportation patterns (cf. Cancer Prevention Research Center, 2011):

Precontemplation to contemplation

- Consciousness raising *(Example: Information about the environmental impact of car use)*
- Dramatic relief or emotional arousal *(Example: Pictures of the impacts of climate change)*
- Environmental re-evaluation *(Example: Demonstration of the effect of living near a crowded road)*

Contemplation to preparation

- Self-reevaluation *(Example: Reflection about one's own motivations for a certain transport behavior, assessing of emotional involvement)*

Preparation to action

- Commitment (*Example: Commitment to change an unsustainable transportation behavior*)

Action to maintenance

- Counter-conditioning *(Example: Substitution of the feeling of freedom and independence of car usage)*
- Helping relationships *(Example: Weekly bike tour with the family, change the transport behavior together with one´s friends)*

Reinforcement management

- Stimulus control *(Example: Controlling the desire for speeding)*

As a summary, the change of behavior according to the transtheoretical model needs:

1. The awareness that the advantages of changing outweigh the disadvantages of changing
2. The confidence that behavioral change can be achieved and maintained (self-efficacy)
3. Strategies that help make and maintain changes.

In this respect, the transtheoretical model proposes similar influence factors for behavior as the theory of planned behavior. The list above, therefore, can be seen as a conclusion on factors of behavioral change for unsustainable transport behaviors.

In the following chapters, the theoretical models are "transcribed" into the world of mobility. Social and psychological patterns of mobility are analyzed and compared with the reality of these models.

1.2.4 Application of Behavioral Models for Sustainable Mobility

The social and psychological reasons behind mobility have not been studied intensively in the past. Although the mobility of goods and people (and, with the increasing use of internet, also the mobility of data and information) has significantly enlarged in the third millennium, social theories lack explanations about the individual reasons for mobility (Sheller & Urry, 2006).

An integrated viewpoint of mobility and its social and technical requirements is necessary to solve the problem of unsustainable transportation patterns, which is described as a commons dilemma (a behavior that is profitable and attractive for the single person, but harmful to society if conducted by many persons), in Vlek (2004). As an introduction into the next chapter, which deals with the reasons for individual transport patterns, the following table compares individual benefits and collective costs of motorized individual transport.

Individual Benefits	Collective Costs / Risks
Availability (continuous)	Space occupation (roads, parking, street life)
Payability (low costs)	Traffic jams, congestion, delays
Speed	Landscape fragmentation (biodiversity)
Comfort (passengers, baggage)	Traffic accidents (prevention and handling costs)
Flexibility	Energy consumption
Reliability	Use of raw materials
Safety-*en-route*	Sold wastes
Privacy	Harmful emissions, air pollution
Freedom, autonomy	Environmental noise
Pleasure, sensation	Costs of infrastructure and maintenance
Social embeddedness	Costs of lawful regulation and enforcement
Social status, distinction	Decline of transport alternatives

Table 2: Individual benefits and collective costs of motorized individual transport, (Vlek 2004).

Reasons for Transport Behavior

Referring to (Stradling et al., 2011), individual transport behavior is determined by the answers to the following four questions:

1. **Activity choice:** "What shall I do?" The answer to this question is very much dependent on social status, age and personal preferences, but also on the place of residence. As more and more people inhabit cities and megacities (UN, 2008), the variety of possible activities is increasing. With new methods of communicating, activity choices become more spontaneous. There is a social need for activities such as meeting friends, doing sports and other leisure trips. Consequently, these trips can hardly be reduced. Still, the majority of transport activities are not actively chosen (commuting, shopping and other procurements).

2. **Destination choice**: "Where shall I do it?" The answer to this question depends on the place of residence of a person: In urban areas, most activities can be conducted in more or less close proximity to the place of residence, while inhabitants of rural areas in most cases will need to travel longer distances for the same activity.
3. **Mode choice:** "How shall I get there?" Otto (2010) lists the following factors to travel mode choice:
    - **Habit & routine:** People tend to stick to their favorite transport behavior.
    - **Attitude:** The attitude towards a certain transport mode plays an important, but not always vital, role in transport choice, as we see in the psychological modeling presented in chapter 1.2.
    - **Situational factors** set the framework for individual decisions. If, for example, no public transport mode is available or if the weather is too bad for riding the bicycle, these transport modes are not an option.
    - **Economic factors,** such as the costs of transport mode are very important for the modal choice.
    - **Information and knowledge** about a transport mode are essential for its use: If information about the next public transport mode is hard to gather, people may chose to go by car, if they have the possibility.
    - **Social norms** have an influence: Depending on the social group of a person, driving a car may be unacceptable or necessary to fulfill the social norm.
    - **Demographic factors** such as age, income, gender and physical ability have a strong influence on mobility: For many older persons, riding a car is much more comfortable than going by bike or by train.
4. **Departure time choice:** "When shall I go?" The departure time of an activity is an important factor, as mobility possibilities vary with the time of day: While motorized transport is less favorable in rush hours, public transport service will be less frequent during very late or very early hours of the day. As travel times become more diverse (the classical 9-to-5 job is replaced by flexible working models, Bauer & Munz, 2005) and transport choices become more spontaneous, public policy is a difficult task with the responsibility of providing transport at the time it is needed.

Two of the important variables of transportation cannot be sufficiently explained by psychological variables: While Infas / DLR (2008) shows that daily travel time is almost constant throughout cultures and societies, Prillwitz & Barr (2009) state that the length of travelled distance is hardly influenced by psychological variables, but that "socio-demographic predictors" like age and employment situation have a greater significance.

The main behavioral approach for sustainable transport hence is the modal choice. Prillwitz and Barr (2009) list the following types of "modal decision makers", which shows many similarities to the "transtheoretical model" displayed in chapter 1.2.3:

- **"Die-hard drivers"** (car owning): People in this group show no intention of changing their transport mode, have strong reservations against the use of other transport modes and a strong car-attachment.

- **"Complacent car addicts"** (car owning) also either have lacking information about the costs of car use, unfavorable attitudes about other transport modes or strong psychological attachment to their cars, but can be influenced by excellent transport alternatives.
- **"Malcontented motorists"** (car owning) are more likely to change their transport patterns because of good sustainable transport alternatives, moral concerns or congestion. However, psychological attachment to the car and low (perceived) self-efficacy are major constraints in this group.
- **"Aspiring environmentalists"** (car owning) have high moral norms towards the environment, a positive view of sustainable transport modes and strong reservations against their cars, but practical reasons, such as the lack of public transport alternatives prevent them from changing their modal choice.
- **"Reluctant riders"** (non car owning) use sustainable transport modes because of a lack of alternatives or financial means. They often have a positive opinion towards the use of cars and are likely to change their transport mode if a car is financeable and practical.
- **"Car-less crusaders"** (non car owning) have strong positive attitudes towards sustainable transport modes and have the possibility to use them.

An empirical study conducted near Manchester, England, provides a detailed overview of attitudes and socio-economic and demographic backgrounds in the different groups (Anable 2005). The same study investigated the shares of the mobility groups in this specific area:

1. Malcontented Motorists (30%)
2. Complacent Car Addicts (26%)
3. Die Hard Drivers (19%)
4. Aspiring Environmentalists (18%)
5. Car-less Crusaders (4%)
6. Reluctant Riders (3%)

To get an idea about the distribution of the car owners, which are likely to change their mobility behavior, a study in the US asked car drivers about their perceived estimation of the likeliness that they would change their transportation patterns: (Stradling, Meadows and Beatty, 2000). Their conclusion was:

"One third (33%) of car drivers indicated they would like to reduce their car use over the next 12 months', but only 7% thought they were likely to. One third (34%) of car drivers would like to use public transport (PT) more, but only 5% thought they were likely to."

While psychological aspects such as attitude play an important role, the provision of transport alternatives is equally important. Habits are strong barriers for everyday travel, even if people know that they should use another transport mode that is affordable and even better. A reason may be the possible costs of the change of transport, as described by Stradling et al. (2011). Examples are financial costs (the new transport mode may be more expensive than the old

one), time costs (the new transport mode may be slower than the old one), physical effort (e.g. riding the bicycle), cognitive effort (behavioral change can be exhausting) and nervous energy (important for public transport, as the gathering of information, the search for the right line and ticketing can require a lot of energy).

Lowering these costs is a major "soft" measure to promote sustainable transportation. A second major approach is the change of attitudes especially towards the use of cars (compare the theory of planned behavior). As Steg (2010) and Stradling (2011) describe, car drivers often perceive their car as status symbol, a way of projecting a particular image of themselves. They perceive it as means of "expressing myself" by driving the way they want to. Driving a car gives them a feeling of power, being in control, safety and self-confidence.

While the car (and even more the motorcycle) is seen as symbol for wealth, independence, autonomy and freedom, public transport and non-motorized transport modes are often perceived as

- Unsafe, intrusive, uncomfortable
- Not fitting into the personal image
- Unreliable

In the next chapter, possible strategies for governmental intervention are assessed.

Strategies for Behavior Change

For the changing of individual transport behaviors, two strategies exists: "Push" and "pull" or "hard" and "soft" measures (Stradling, Meadows and Beatty, 2000). While "push" or "hard" measures include regulatory approaches and fiscal measures intent to force a behavior change independent of attitudes or values, "pull" of "soft" measures aim at increasing the real attractiveness (service quality etc.) and the perceived attractiveness (values, attitudes) of sustainable transport alternatives. For examples of "push" and "pull" measures, please refer to Table 3.

Push measures	Pull measures
Increase costs:	Persuasive communications:
Raise fuel prices	Anti-car use propaganda
Raise parking charges	
Tolls by place (e.g. motorways) or time	Spread or reduce demand:
	Stimulate flexi-time and teleworking
Decrease availability:	Traffic reducing urban planning
No city center car access	
Reduce or eliminate city center parking	Reduce procedural uncertainty:
No new road construction	Improve availability of information
Lower speed limits	Well publicized role modeling
	Improve alternatives:
	More and better cycle tracks, car pool lanes
	Better public transport vehicles and interchanges

Table 3: Examples for "push" and "pull" measures, adapted from (Stradling, Meadows and Beatty, 2000)

Of course, different travel situations require different measures: Vlek (2004), for example, states that holiday travel decisions are more conscious than every-day mobility. Therefore, soft measures such as image campaigns might be successful for holiday travel, but *"information will certainly not be enough to change everyday mobility patterns"*.

He concludes that hard policy measures, which change situational and economic factors to raise awareness of every-day travel patterns, are necessary. Especially if people are dependent on a certain transport mode, soft measures are often not powerful enough to change travel patterns. The perspective of the car users themselves of course is different (Stradling, Meadows and Beatty, 2000). The study summarizes:

"Effectiveness ratings of pull and push policy measures showed motorists would rather be pulled than pushed from their cars; that the old, the poor and urban dwellers would be more susceptible to push measures; and that those residing out-of-town, driving medium and large cars, driving high annual mileage and required to drive as part of their work are less likely to be persuaded to reduce their car use by either type of measure."

Nehring & Steierwald (1999) come to similar conclusions, but remark that people are more likely to accept measures that expand their scope of action rather than restrictive measures and that the knowledge about the effectiveness of certain measures is limited.

Bamberg et al. (2009) cite studies that show an average reduction of 7% in the modal shares of cars in the total trips can be achieved with awareness campaigns.

Nehring & Steierwald (1999) state that restrictive or "hard" measures such as financial measures have a higher short-term effect while the extensive and long-term commitment to "soft" or persuasive measures has higher long-term impacts. Empirical success examples of image campaigns for sustainable transport modes can be found from Brög, et al. (2009). Otto (2010) states that

"...hard and soft measures should not be considered separately, as research shows that especially hard measures have to be supported by soft measures in order to succeed or to become more effective."

According to Bamberg, et al. (2009), hard measures such as the improvement of service quality of public transportation are often necessary for a successful implementation soft measures (image campaigns for the use of public transport).

It can be concluded that soft measures are more efficient for long-term behavioral change, while hard measures can produce short-term success. For an efficient and sustainable behavioral change, however, both measure types have to be combined.

An important concept in this respect is "elasticity", which describes to what extent people can be influenced in their transport patterns. The higher the elasticity of modal choice, the more flexible a person is his transport choice and the easier he can be convinced to switch modes. Of course, different trip purposes have different elasticities (emergency and commuting trips, for instance, have lower elasticity then recreational trips, compare VTPI, 2011))

Vlek (2004) notes that policy makers have to consider the side effects of measures for sustainable transportation, such as changing social interaction, spending patterns and more,

which may cause these measures to be less efficient or even rejected. Limiting general availability of transport, for example, would have severe social consequences.

Steg and Gifford (2005) criticize that the perceived assessment of "quality of life" by concerned transportation users is often not taken into account by policy makers. The anticipated change in "quality of life" is not always based on facts, but is strongly influenced by emotions and perceptions. This "emotionality" is not always taken into consideration in political measures.

An example could be a campaign by the German Federal Government for the use of electrical mobility, which does not consider that electrical cars may not give the same "feeling" as a car with combustion engine (sound, acceleration and more): (WELT, 2011). Hence, especially soft measures should include an emotional component, as facts alone are not enough to change mobility behavior. Nevertheless, the German Federal Government, along with many more countries, focuses on technical solutions for sustainable mobility (electrical mobility, biofuels) without trying to change mobility behavior. They try to lead society into the belief that one could maintain the mobility behavior that lead to the unsustainability of the transport sector, and still "save the environment". Stradling, Meadows and Beatty (2000), however, suggest the following steps to change transport behaviors:

1. Work with plausible reasons and explanations (including the expectation of other persons) instead of forcing people to a behavior they do not understand and do not accept.
2. Suggest alternative behaviors and, explain why they benefit the target persons and their surroundings.
3. Give assistance for the target behavior and help the target person to stick to the desires behavior.
4. Show that policy makers make all possible efforts to help the target person in adopting the desired behavior; show that the new behavior is of concern to key decision makers.

1.3 Conclusion

As an unsustainable transport system mainly consists of many individual unsustainable transport decisions, psychological models for behavior and behavioral change are of crucial importance for policy makers in order to improve the sustainability of a transport system. As main influence factors, the attitude towards a new, more sustainable behavior and the cost of a new behavior have been identified. Behavior can be influenced by "push" or "hard" measures, which use economical or regulatory means of behavioral influence, or by "pull" or "soft" measures, which aim at giving incentives for a new transport behavior by changing the attitude toward it. While the use of the latter is favorable if its effectiveness is high, literature is inconsistent in answering the question of which measure category is more effective. In the following chapter, policy measures are further categorized and described.

2. Strategies for Transport Sustainability

As mentioned above, the goal of this master thesis is to evaluate the effectiveness of different policies of the German Federal Government with respect to sustainable mobility in the sector of land transportation. In chapter 1, a crucial prerequisite for sustainable mobility was explained: The need for behavioral change. In this chapter, different categories of policies for sustainable transportation are introduced and the effects and difficulties accompanying transport measures, like the effect of "induced travel", are explained. The focus in this thesis is on three measure categories: Regulation, economic measures and "soft" measures. A popular method of categorizing measures for environmentally friendly transport is the ASI approach.

2.1 ASI Approach

With reference to GTZ (2010), there are three main strategies to make transport more sustainable and thus lower the emissions in the transport sector: *Avoid, Shift* and *Improve*. In Figure 4, possible avoid, shift and improve measures are analyzed for their cumulative effect on the European transport emissions.

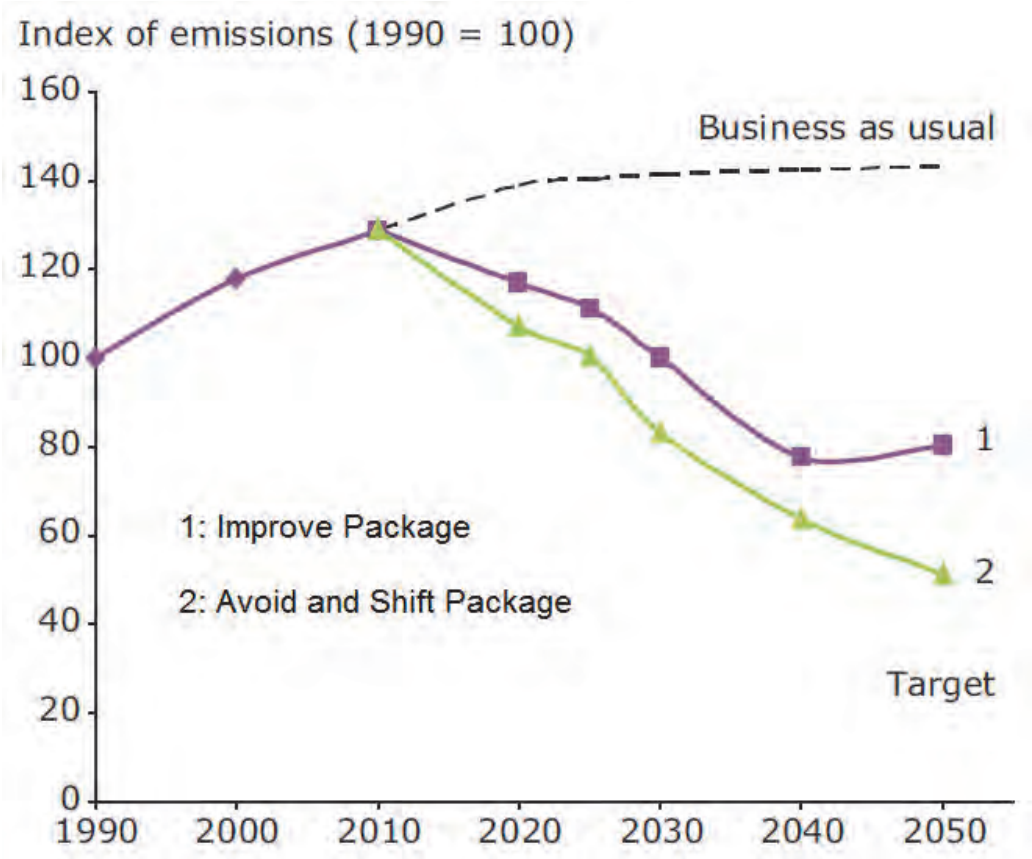

Figure 4: Combining A, S and I measures can release additional potentials, adapted from EEA (2009a)

2.1.1 Avoid

⇨ *Relevant Indicator: Total person kilometers per year*

Avoiding traffic should be a crucial part of each strategy that promotes sustainable transport. The idea behind traffic avoidance is that it is possible to maintain the same mobility of the people with less traffic: An efficient transport system allows people to use it as usual with minimized person kilometers.

Necessary for traffic avoidance are proper land-use and urban planning strategies ("City of short ways") with a dense and mixed structure that allows inhabitants to take care of their business within a short distance (ideally walking distance) of their residences. Structures of business, industry and residence have to be well planned, the density of cities increased, and existing construction gaps filled. Negative examples for inefficient urban planning are the very area demanding US cities that extend the need for individual motorized transport.

The promotion of locally produced goods and local industries can decrease the demand for transportation rapidly: An important factor of both freight and passenger transportation demand is the rising demand for goods that are produced and sold far away from the consumer. If more goods are produced locally, transportation can be decreased.

The most prominent reasons for the dramatic traffic growth in Germany (cf. chapter 7.5) are (UBA, 2005c):

- Urban sprawl and traffic inducing urban planning
- Expanding trade networks
- Increasing wish for leisure mobility and traveling
- Expansion of transport infrastructure (induced traffic, cf. chapter 2.2).

Next to urban and transport planning, campaigns raise public awareness and encourage private persons and companies to avoid unnecessary or empty trips. Fiscal measures are possible as well: If fuel taxes are raised, people may be encouraged to drive fewer kilometers with their personal vehicles. Legal measures of the federal government of Germany are implemented in the Federal Building Code and the Territorial Planning Code.

Traffic avoidance mainly happens through long-term planning and can be subject to expensive infrastructural measures. Equally important to reducing traffic is the shift to more sustainable transport modes.

2.1.2 Shift

⇨ *Relevant indicator: Modal shares of transport modes*

Emissions of transportation are very much dependent on the transport mode: Public transportation, whether on road or rail, in most cases emits a lot fewer harmful substances per passenger or freight kilometer than aviation or private motorized vehicles. In urban areas, walking and bicycling are the fastest transport options for most trip lengths (cf. Figure 5). For this reason, it is very important to adopt measures that shift the modal shares of transportation modes

from private vehicle road transportation and aviation to public transit and non-motorized transportation modes (walking and cycling). As explained in chapter 1, behavioral measures are important to induce modal shifts and are necessary if Germany wants to achieve a sustainable reduction of (especially CO_2 -) emissions. Despite all efficiency improvement and emission reduction measures, which are introduced in chapter 2.1.3, an estimated 30% efficiency improvement (IEA, 2011) by 2050 will not be enough if passenger car kilometers are keep on rising – for that reason, a modal shift is of great importance.

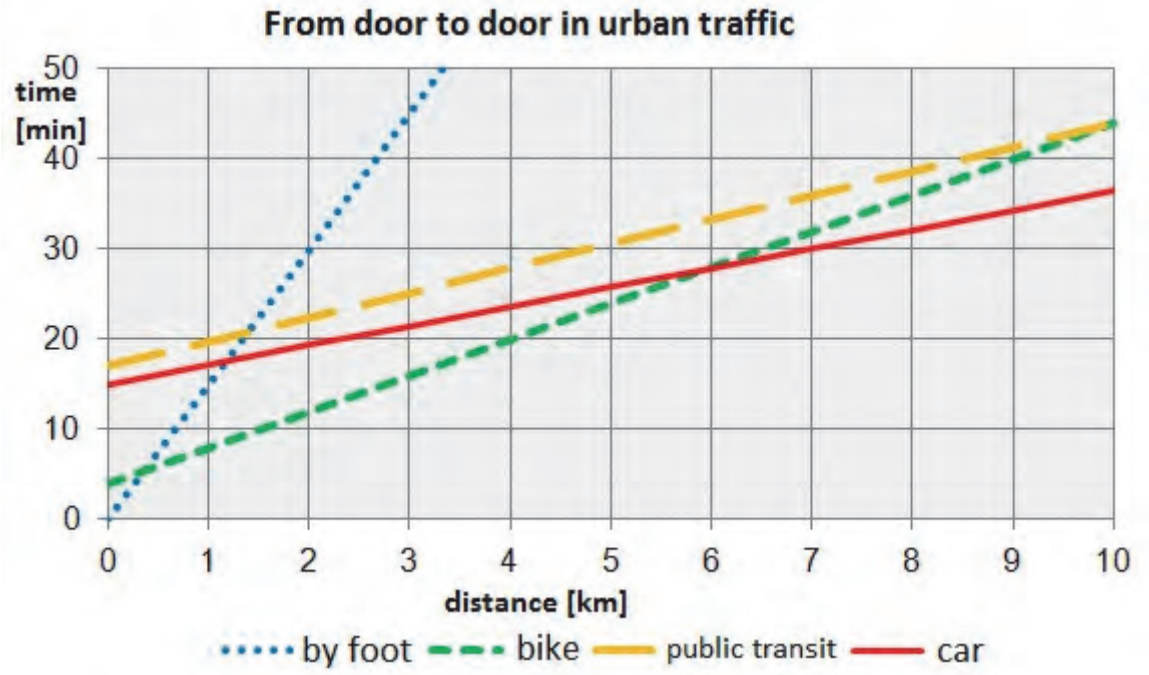

Figure 5: Travel times in urban areas: Different transport modes. Adapted from UBA (2011d)

Public awareness campaigns can be quite successful, although one could argue that all information needed for a rational choice of transport modes is easily accessible. Information, regardless, is not enough for a behavior change (for a discussion and good-practice examples see Wuppertal Institute (2008) and Böhler, et al. (2010)). (Financial) incentives to use public transportation are the most important governmental influence possibilities. The regulatory possibilities are rather limited and include the prioritization of public transportation in urban planning and disincentives measures such as traffic calming for the use of passenger cars.

Measures that aim for a modal shift are mostly about incentives that make public transportation more attractive to people and encourage them to use transport modes other than their cars. There are also disincentive measures that can help lowering the attractiveness of higher emitting transport modes, such as traffic calming for personal cars.

Even without shifting or reducing traffic, an improvement of existing transport vehicles can reduce environmental impact.

2.1.3 Improve

⇨ *Relevant Indicator: Emissions in g/km for the different transport modes*

It is important to improve existing vehicles and travel efficiency in order to decrease the specific emissions per person kilometer. A reduction of more than 50% is possible for passenger cars (Wuppertal Institute, 2006). The improvement of vehicle efficiency and vehicle emissions has many subcategories:

- Increase of occupancy rate: The emissions per person kilometer are smaller the higher the occupancy rate of a transport mode is. It is mainly because of the higher occupancy that public transportation modes are more sustainable than passenger cars, which usually carry in average less than two persons (Infas / DLR, 2008). Measures to enhance the occupancy rate of passenger vehicles and public transportation vehicles can save vehicle trips and therefore decrease emissions.
- Technical measures to increase vehicle efficiency: Lightweight materials, better tires, downsizing of motor capacity and other efficiency improvement help decrease vehicle fuel consumption and, therefore, the emission of harmful substances.
- Decrease fuel emissions: New fuels, such as liquid gas and biofuels, the improvement of gasoline and diesel, or the improvement of the electricity mix can lower (life cycle) emissions of vehicles.
- Driving behavior: The driving behavior of vehicle drivers has a significant influence on fuel consumption and emission of (especially road) vehicles: Fuel consumption can vary by a factor of two, as a recent US study found (US Department of Energy, 2009).
- Environmental conditions: Emissions, especially in road transportation, are significantly influenced by environmental conditions such as traffic volume, temperature and weather conditions. Measures that reduce traffic volume can help reduce congestion and lower the vulnerability to weather influence fuel consumption and thus help lowering emissions.

The improvement of vehicle technology to lower emissions offers law many regulation possibilities: German law tightly regulates emission standards, fuel emission thresholds, and vehicle emission monitoring.

Improvement measures have the advantage that regulation is relatively easy and that costs are often translocated to the buyer of the new technologies – their impact, however, is limited, as long as the mindset towards “dirty“ transport modes is not changed. A cost-benefit analysis of technical improvements for mobility in Germany can be found in Figure 6.

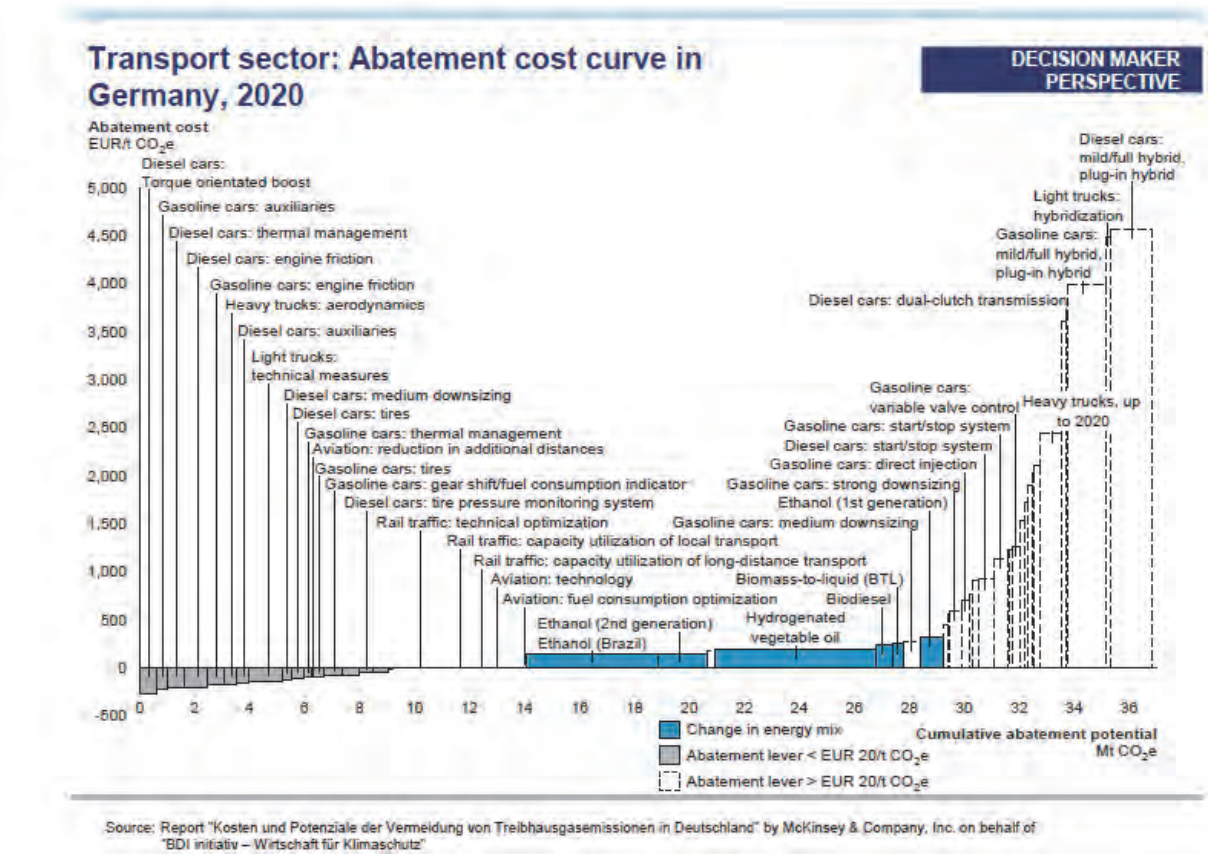

Figure 6: Costs and benefits of technical improvement measures in the transport sector (McKinsey, 2007).

As the transport system is strongly connected to economy and other public sectors, side effects will always occur.

2.2 Side Effects

Measures heading towards a transportation system with lower emissions should never be assessed in isolation – there are side effects that can enhance the originally planned effect ("multiplier effects") or act against the proposed effect ("rebound effects").

Multiplier effects often occur when some measures are being introduced simultaneously – measure packages thus have a higher probability of success compared to the independent implementation of measures.

Rebound effects occur with almost every measure or regulation; examples are regulations that lower the fuel emissions of passenger vehicles and aim to decrease emissions. Vehicle owners as a result tend to use their cars more frequently because of lowered costs, which works against the proposed effect.

Another example is the phenomenon of "induced traffic", which describes the effect that traffic reduction or shift leads to a growing traffic demand (because of the improved traffic situation). This works as a counteracting force for the improved traffic situation.

Typically, the rebound effect of private transportation measures decreases the effect of the original measure by around 10-30% (UKERC 2007, p.50) and has to be taken into consideration when at the planning stage of a transportation measures.

An important issue that should be taken into account is the so called "investor-user dilemma", which describes the fact that those who profit from improvements of transportation are usually not the ones who pay for it. Local and federal governments usually finance transportation improvement measures while the users of the transport system profit from it. Thus, investments and regulation efforts toward sustainable transportation do often not have a very high priority and it is even feared that the economy will suffer and jobs will be destroyed if, for instance, regulations become stricter. Chapter 2.3 gives an overview of possible transport measures of the federal government.

2.3 Policies for Sustainable Transportation

Table 6, which is attached in the annex, provides a non-exhaustive overview of important policies for sustainable transportation and shows the variety and approximate mitigation potential and costs for sustainable mobility in Germany. Priorities were assigned to the policies based on mitigation potential, costs and feasibility in Germany. Please note that not all measures can be strictly separated, and thus the mitigation potential of the measures cannot be added: The implementation of different measures causes interferences (for example by a reduction of the total emission basis). UBA (2010) estimates that the total reduction of certain measures that are implemented at the same time, can reduce to 50-80% of the sum of the potentials of the measures.

For the evaluation of the policies of the German Federal Government, the scope of the policies must be considered: Many policies are the responsibility of local governments, companies or the car industry. Nevertheless, they were also evaluated if the Federal Government has tried to influence the promotion or implementation of these policies.

2.4 Policy Principles of the German Federal Government Concerning Sustainable Transport

The goal of federal environmental policy in Germany was described in its first environmental action plan in 1971 (Simonis, 2001):

"Environmental politics is the entirety of measures which are necessary to secure an environment for man, as it is needed to ensure health and human life and for the protection of soil, air, water and plant and animals from human influence and to remove harm and disadvantages from human interference."

This shows that the goal of environmental protection – including reducing the emissions from the transport sector – is an explicit goal of the federal government, whose implementation can and will be assessed in this study.

In the same action plan, which was expanded in 1976, the following principles of environmental policy were announced (ibd.):

- The "causer principle": The subject responsible for an environmental harm is liable for its removal.
- The "common burden principle" (Gemeinlastprinzip), which puts the burden of the

removal of environmental harms upon the government and, therefore, on the taxpayers (Wirtschaftslexikon, 2010). This principle is used when the "causer principle" cannot be.

- The "precaution and cooperation principle": Environmental harm is to be avoided before it is created. This task should be done in cooperation of the federal and local government, environmental organizations, companies and society (Juraforum, 2010).
- The "integration principle" (environmental politics as interdisciplinary task).

Here we can see the basic principles set by the federal government, which are, nevertheless, often not respected, as we will see in the course of this study. Especially the "causer principle" is often violated in German environmental transportation law (cf. chapter 7.1.).

The federal government describes its goal concerning transport and environment with (Federal Ministry of Transport, 2000):

"We want to increase the environmental friendliness of transportation and thereby also ensure the mobility of future generations".

This goal is to be achieved by limiting land use, increasing (fuel-) efficiency and the introduction of new fuels (ibid.). Here, a clear commitment to the removal and prohibition of not only present but also future environmental problems is given. Hence, especially the problem of global warming caused by greenhouse gas emissions should be the focus of policy makers. An important policy instrument of German transportation policy is the "Bundesverkehrswegeplan" (Federal Transport Infrastructure Plan), which describes the necessary investments in transport routes for the next 15 years (the current plan runs from 2001 – 2015, information available from Federal Ministry of Transport, 2010a). It is often criticized that this plan has a focus on road transportation and is very inelastic due to its long lifetime (cf. chapter 8).

In 1998, the German Federal Government published a number of targets concerning transport sustainability they wanted to achieve until various target years (Aachener Stiftung Kathy Beys, 2011). In 2002, a big "sustainability concept" for Germany was announced, with various goals also for the transport sector, based on 7 action fields (German Federal Government, 2002):

- Traffic avoidance
- Modal shift
- Investments in infrastructure
- Interconnection of transport modes
- Lowering of environmental harm, security improvements
- Promotion of mobility research
- International cooperation

The next program that included goals for sustainable mobility was the "integrated energy and climate protection plan" propagated in 2007 (UBA, 2011a). The plan included a CO_2 thresh-

old for passenger cars (which was, however, set by the EU, not by the Federal Government), a further expansion of biofuel quotas with more stringent targets for the sustainability of those fuels, the introduction of car taxation on a CO_2 basis, and improved labeling of the energy consumption of new cars. The conducted measures were estimated to save 10-30 million tons CO_2 per year. Additionally, measures for sustainable transport within federal ministries were announced in 2010 (Federal Government of Germany, 2010).

The program of the federal government for the promotion of sustainable transportation for the coming years is described in (German Federal Government, 2010):

- Promotion of innovative propulsion technologies such as electric mobility and fuel cell vehicles
- Further expansion of biofuels
- Labeling for car fuel consumption
- Promotion of a legally binding CO_2 threshold for passenger cars (at EU level)
- Basing car taxation on CO_2 emissions.

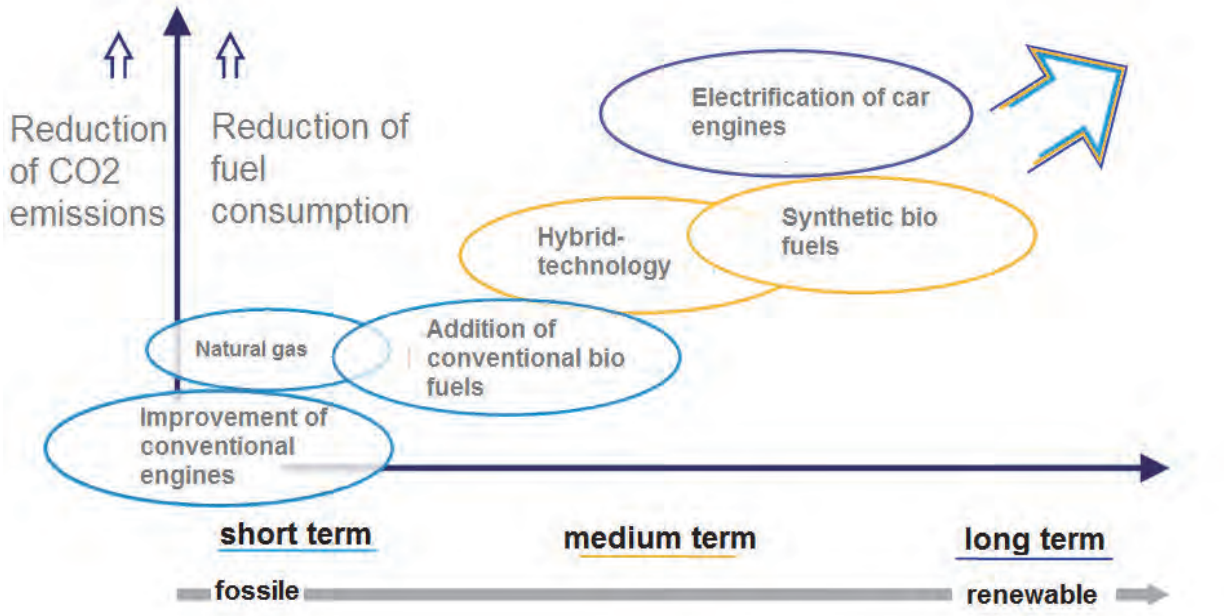

Figure 7: German policies for sustainable transport, adapted from (Federal Ministry of Transport, 2011)

Looking at these measures (an overview is available from Figure 7), it becomes clear that they can be conducted without too much effort or financial commitment.

A central point of the sustainable mobility concept of the German Federal Government is the promotion of electric mobility. In the development plan, the goals of one Million electric cars by 2020 and six million by 2030 were announced (Federal Government of Germany, 2010).

Summarized, the following goals for sustainable mobility have been announced by the German Federal Government since 1998:

Goals set in 1998:

- Decrease of road transport emissions by 5% by 2005 (basis: 1998).

- Decrease of total emissions by 25% by 2005 compared to 1990.
- Reduction of the fuel consumption of passenger cars by 25% (2005) / 33% (2010).
- De-coupling of the relationship of GDP and transportation demand (as shown by VTPI (2010), travel demand grows by 0.65% - 1.25% if wages increase by 1%). In 1999, this goal has been substantiated (UBA, 2011): The transport intensity (transportation demand divided by GDP) is supposed to decrease 5% in freight transportation and 20% in passenger transportation by 2020 (compared to 1999 levels).
- Lowering of land use for transportation and residential purposes to 30 ha/d by 2020.

Goals set in sustainability concept 2002:

- Decrease energy consumption of the transport sector by 10% by 2020 and 40% by 2050 compared to 2005 levels

Goals set in the national cycling plan:

- Increase the modal share of bicycling by 2012 (compared to the year 2000): (German Transport Ministry, 2002)

Goals set in the electric mobility development plan:

- One Million electric vehicles by 2020
- Six Million electric vehicles by 2030

Goals set in the integrated energy and climate protection plan

- 6.25 biofuel quota for 2010-2014, 35% greenhouse gas reduction of biofuels compared to conventional fuels

Evidently, the German Federal Government has set ambitious goals; in the following chapters, a description of the concrete measures for sustainable mobility will follow, starting with the regulatory approach.

3. Legal Measures for Sustainable Transportation

This chapter acts as compendium for those legal measures of the Federal Government of Germany, which affect the sustainability of transport in Germany.

In German transportation law, the federal government is the main actor and has the exclusive legislative power in aviation and railway, as long as these transport modes are partly or totally operated and owned by the federal republic (Art. 73, Nr. 6 and 6a *German Basic Law*). Concerning road transportation, the principle of "concurrent legislation" is applied.

According to article 71, Nr.1 German basic law, the federal states of Germany have the legislative power as long and in so far as the federal government has not applied any regulation on a specific topic. The federal government has made extensive use of this privilege in the area of transportation. That means that regulatory law concerning environmental topics in the transportation sector is mainly the responsibility of the federal government. Consequently, the federal government is the key actor for the improvement of the German transportation system and its role will be assessed in this study.

The federal states have the responsibility of implementing the regulations made by the federal government as well as the planning and construction of the German federal motorways (Autobahnen). Still, financing is mainly the responsibility of the federal government.

The regulations of the German Federal Government cannot be analyzed isolated: European law affects the federal law in Germany and mainly consists of two elements:

- *Regulations,* which are direct binding law and come into effect immediately for all members of the European Union and
- *Directives,* which need to be transposed into federal law by the member states within certain boundaries.

We see that German transportation law is mainly a federal responsibility because of the principle of "concurrent legislation". The different influence possibilities of EU law, however, complicate an analysis of law in Germany.

In the following chapter, different regulation possibilities and their current implementation into German law are introduced and categorized based on the ASI model (cf. chapter 2.1).

3.1 Emission Regulations in Germany

The general law basis for combating air emissions is the *Federal Emission Control Act* (BimSchG).In Paragraph 1, chapter 1, the aim of this law is explained:

"The aim of this law is to protect humans, animals and plants, soil, water, the atmosphere as well as cultural and other goods from harmful environmental effects and to prevent the creation of harmful environmental effects." (author's translation)

§48 regulates the introduction of emission thresholds by the federal government – with reference to this paragraph, regulations setting concrete standards are announced. §38, paragraph 1 of the BimschG talks about the necessity for vehicles to emit as little as possible:

(…) "They have to be run in a way that avoidable emissions are prevented and non-avoidable emissions are kept to a minimum" (author's translation)

Here, the "precaution principle" is applied – still, no definition is given for what "avoidable" means or what constitutes the "minimum" for unavoidable emissions. Therefore, this regulation may not be strict enough. Paragraph 2 talks about emission standards and the responsible institutions (and also about the implementation of EU regulations).

An important EU directive is the *Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on Environmental Liability with Regard to the Prevention and Remedying of Environmental Damage* and its implementation into German law from 10.5.2007, the *Environmental Damage Act*. This regulation gives the responsible person for environmental damage (financial and legal) liability for that damage. Here, the "causer principle", which is not applied often enough, is being formulated. Instead, environmental damages are too often paid by society (cf. chapter 7). In the next chapter, transport mode specific environmental regulations are analyzed.

3.2 Transport Mode Specific Regulations

3.2.1 Road Transportation

Federal law regulates road transportation law in Germany. The main regulation that deals with road transportation is the *Road Transport Act* (Straßenverkehrsgesetz, StVG) that provides general regulations and gives in §6 the power to implement new regulations to the federal government. An important law is the *Highway Code* (Straßenverkehrsordnung, StVO), which regulates the behavior of all persons taking part in road traffic. §30, paragraph 1 prohibits unnecessary pollution and noise annoyance:

"While using road vehicles, unnecessary noise and avoidable pollution is forbidden" (author's translation)

Again, "avoidable pollution" is forbidden and again it is not defined – does, for example, excessive speeding fall under this category as well? More road transportation statute books are the *Vehicle Admission Regulation* (Fahrzeugzulassungsverordnung, FZV), which regulates the properties a vehicle is required to have to be allowed on public road traffic, the (older and slowly dismissed) STVZO (*Road Transportation Admission Regulation*) and the *Driving License Regulation* (Fahrerlaubnisverordnung, FeV), which regulate the prerequisites for drivers to take part in road traffic. Additionally, the federal highways have their own regulation, the *Federal Highways Act* (Bundesfernstraßengesetz). Further, each state of the Federal Republic of Germany has additional *Road Acts* (Straßengesetze). We can see that road transportation regulations are split up into many statute books, which makes it difficult to find specific regulations and thwarts an effective law making process – which could be one reason that road transportation demand is still on the rise. Smeddinck (1995) criticizes that the German road transportation law is

"not the result of a homogenous law making process. Moreover, it is the result of punctual regulations, which were set to combat current problems."

As responsible institutions, the road administration agencies and regulatory agencies are under federal state supervision as well as the road construction authority.

3.2.2 Railway

The main regulation concerning railway transportation in Germany is the *General Railway Act* (AEG), whose purpose is to "ensure a safe and attractive railway service" (§1, chapter 1), in §26 the transport ministry is given the right to enact additional regulations. Important regulations include the *Railway Transportation Act* (EVO) and the *Railway Construction and Operation Act* (EBO). There are special regulations for trams (*The Tram Construction and Operation Act* (BOStrab)) and magnetically levitated vehicles.

3.2.3 Public Transportation

Public transportation law is a special area of law and is influenced by European Law such as regulation 1370/2007 on public passenger transport services by rail and by road with the goal listed in §1.1:

"The purpose of this regulation is to define how (...) competent authorities may act in the field of public passenger transport to guarantee the provision of services of general interest which are (...) more numerous, safer, of a higher quality or provided at lower cost than those that market forces alone would have allowed."

This regulation is remarkable since it implies that publicly owned and run transportation can be provided more frequently, better, at a higher quality and with lower cost than privately owned transportation. As we will see, it is partly this policy that prevents a modal shift to the more efficient "mass" transport modes. German law provides the *"Person Transportation Act"* (Personenbeförderungsgesetz) with regulations about responsibilities in public transportation as well as regulations for different public transit modes. In §57, the transport ministry is given the right to enact additional regulations as well as emission thresholds (we will come back to this later). An excellent overview of the complicated German public transportation law, which cannot be covered in detail here, is available from http://www.personenverkehr.eu and BDO (2007).

In this chapter it is shown that road transportation law is composed of many law books, making an analysis difficult. Railway law is the subject of compact law books, while public transportation law is only partly a federal responsibility and is mainly done on a state or community level. Now we proceed to regulations in the ASI (*avoid, shift, and improve)* categories.

3.3 Urban Planning

⇨ *Relevant Indicator: A (Total transportation demand in km) and S (modal shares)*

Proper urban planning is a key instrument for sustainable urban transport. Concepts such as the "city of short ways" with dense and integrated structures allow an overall traffic reduction and can, in combination with public transport planning, lead to a modal shift towards sustainable transportation modes (UBA, 2010). Moreover, disincentives for the use of private motorized transport can be given. UBA (2002) offers an excellent overview of the topic of car-free urban living and shows that the concept of "car-free mobility" has already become reality for about 25% of the German population, mainly inhabitants of cities. It is shown that the reduction of traffic by a dense city structure is particularly effective for shopping traffic, less effective for commuter traffic and does not have any influence on leisure traffic (ibid.).

The law book concerning urban planning is the *Federal Building Code.* §1.5 states:

"Urban land-use plans shall ensure a sustainable urban development. (...) They shall contribute to the preservation of a humane environment and to the protection and development of the natural basis of life, also in responsibility for climate protection" (Author's translation)

This regulation shows that environmental protection should be one of the key factors considered in any urban structure measure. Even more, climate protection must be promoted. Hence, traffic avoiding urban structures should not be the exception but the norm. §1.9 talks about the promotion of public transportation:

"When installing an urban land-use plan, the following points have to be considered:(...) the matters of environmental protection (...), especially (...) the use of renewable energy sources, (...) the preservation of the best possible air quality, (...) the matters of person and freight transportation (...), including public transit and non-motorized transportation modes, under special consideration of an urban development that promotes avoidance and reduction of traffic." (Author's translation)

Here, it can be seen that public transportation and non-motorized transport as well as traffic avoiding measures must work together in Germany´s urban planning. This "strategic environmental examination" was implemented in 2004. When comparing these ambitious goals to reality, however, we will see that they are not always kept (chapter 7.1). Furthermore, it is not said in which way these environmental goals should be considered.

Also relevant to urban planning is the *Territorial Planning Code (ROG),* which in §2.2.3 talks about sustainable transport:

"The spatial requirements for sustainable mobility and an integrated transportation system are to be created. Especially in areas with high traffic density, prerequisites for a modal shift towards environmentally friendly transport modes such as railways and waterways are to be created. Spatial structures have to be designed such that traffic is reduced and additional traffic is avoided." (Author's translation)

Here, we see even more clearly the goals the federal government has imposed upon urban land planners: Requirements for a modal shift and traffic avoidance are to be created. There-

fore, the assessment standards for the German environmental transport law should be quite high in light of its own high goals. UBA (2003a) shows that it is legally possible to limit areal growth of communities and cities. Nevertheless, lawmakers have not used this possibility, although – as we will see in chapter 7.1.1 – it was necessary. A publication about the general influence of the federal government on urban planning can be found in BBSR (2009). More publications and analysis can be found from Federal Ministry of Transport (1993), BBSR (2004) and ILS (2006). Urban planning and settlement structures are important means of adjusting, especially for traffic avoidance. This chapter showed that German law has a strong commitment to sustainable transportation in their urban and territorial planning law books and recognizes that city structures have a very high impact on the sustainability of transportation. A similar approach for traffic avoidance is the promotion of regional economic cycles.

3.4 Promotion of Regional Economic Cycles

⇨ *Relevant Indicator: A (Total transportation demand in km)*

Regional economic cycles work contradictory to globalization and promote the production of goods and services near to the place where they are consumed and needed. The creation of regional economic cycles can lead to a significant reduction in traffic volume for freight transportation and person transport (for example shopping trips), and is, thus, an efficient way of traffic reduction (UBA, 2010). The *Treaty on the Functioning of the European Union*, Art. 174 has a strong commitment to regional economic cycles, financing comes from the European Regional Development Fund. Hence, Germany is obliged to care for less developed regions.

In Germany, the federal states are responsible for the promotion of regional economic cycles, with financing shared between federal government and the states, referring to Charta of the German Federal Republic, Art. 91a, paragraph 1. Germany showed a commitment to the improvement of regional economic structures before the EU and even included this goal in its charter. Therefore, it can be considered an important goal of the federal government. The exact interaction between Federation and federal states is regulated in the *"Regulation about the Common Task 'Promotion of Regional Economic Cycles'"* (GRWG). More information and an evaluation about regulation possibilities can be found in UBA (2003b).

In German law as well as in EU law, there is a commitment to the financial promotion of regional economic cycles; however, no connection to sustainable transportation or traffic avoidance is given here. Given an overview of German regulations for avoidance measures, a drastic measure to traffic avoidance and modal shift will be introduced: Environmental zones and driving bans.

3.5 Environmental Zones / Driving Bans for Dirty Cars

⇨ *Relevant Indicator: Emissions in kg*

So called environmental zones or "Umweltzonen", which are areas especially in the inner core of cities that are accessible only by vehicles that comply to the most recent pollution

standards, are an attempt to lower pollution, especially of particulate matter. This measure could be categorized in any of the three ASI categories: It could contribute to less traffic in environmental zones and drivers of dirty cars are forced to shift to other modes; also, incentives for the purchase of cleaner cars are given. In Germany, the air quality standard of 50 µg/m³ may not be exceeded more than 35 times per year, an implementation of directive 1999/30/EG into German law (*22nd Regulation for the Realization of the Federal Emission Control Act,* 11.9.2002).

Still, the threshold was exceeded by many German cities, and as a result, the introduction of driving bans in the "Umweltzonen" especially for PM emitting diesel vehicles was implemented into German law. The regulatory foundation for the environmental zones was made on March 1, 2007: In §40.2 and §40.3 of the *Federal Emission Control Act* (BimSchG) it is stated that

"The competent road traffic authority may restrict or ban motor vehicle traffic on certain roads or in certain areas (...), where such motor vehicle traffic contributes to pollution levels exceeding the immission values (...), in order to reduce any harmful effects on the environment caused by air pollution or prevent the formation thereof."

"The Federal Government is authorized (...) that motor vehicles with low pollutant emissions are or may be wholly or in part exempted from traffic bans and to determine the relevant criteria for that purpose and the official marking of these motor vehicles."

This remarkable regulation reaches can ban vehicles completely in special zones for environmental reasons – a new concept. Only low polluting vehicles can get a permit for driving in these zones. Remarkable as this regulation may be, it remains unclear whether vehicle traffic and emissions are reduced in total or are just shifted to suburbs (UBA, 2010).The *"Regulation for the Labeling of Low-polluting Vehicles",* of the *35. BImschG* from March 1, 2007 regulates exceptions for driving bans and thus gives the legal background for the "Umweltzonen". Diesel vehicles in Germany are categorized based on their PM emissions: Vehicles in the highest emission category do not get any label; the next categories are red, yellow and green labels for the least polluting vehicles. A list of the participating cities can be found in the UBA database, available from (UBA, 2011f).

As we see, German law provides the possibility of banning dirty vehicles in special zones for cities and communities. It is interesting that, legally, all vehicles can be banned and that low-polluting vehicles just have a permit to enter banned zones. It has to be carefully evaluated if emissions are just shifted to the outer areas of cities or if they are actually reduced. Now, regulations for the promotion of public and non-motorized transport, which are in general the most environmentally friendly transport modes, are presented.

3.6 Promotion of Public and Non-motorized Transport

⇨ *Relevant Indicator: S (modal split in %)*

A very important instrument of sustainable transportation is the promotion of environmentally friendly transport modes of public transportation and non-motorized transport modes (walking

and cycling). Although the promotion of environmentally sound transport modes is mainly done by awareness campaigns and fiscal incentives or disincentives that are the responsibility of the counties or states, there are some legal influence possibilities for the federal government.

The construction and maintenance of public transit and the promotion of sustainable transport on a state and county level is promoted by the *"Devolution Act for Public Passenger Transport"* which gives the responsibility for public transit to the states (§1). The "Länder", however, are financially supported by the federal government referring to §5 with resources from oil taxation (including fuel taxation). The *"Act for Financial Support of the Federal Government for the Improvement of the Transportation Situation in Municipalities"* sets the possibility for indirect financial support of up to 60% (§4.1, via the states) from the federal government to the counties for the improvement of the local transportation situation.

We see the federal government has shifted responsibility for public transport to the states while at the same time supporting them financially. This may not be a bad thing since the states do not necessarily have fewer competences for the implementation of a proper public transportation. However, no quality standards or goals are connected to this financial aid, which causes problems, as we will see in chapter 7.1. In conclusion, it can be said that public and non-motorized transportation law is not mainly the responsibility of the federal government, but a certain (mainly financial) influence of the federal government persists. A special case is public procurement: Public institutions have to consider environmental standards when purchasing new vehicles (Heuking, Kühn, Lüer, & Wojtek, 2011), which is an implementation of EU guideline 2009/33/EC. Given this overview of transportation law with the goal to promote a modal shift, we now turn to individual vehicle emissions regulations.

3.7 Reduction of Emissions of Electricity Driven Transport

⇨ *Relevant Indicator: F (CO_2 - Emissions of electricity in g/kWh)*

The (indirect life cycle) carbon emissions of electricity driven transport modes are created during the production of electricity from fossil fuels or nuclear power (which has a big carbon emission for construction and resource extraction and other environmental effects: NGO-online, 2007). Referring to UBA (2010), these emissions account for around 572 g/kWh. With the "*Regulation Concerning the Supremacy of Renewable Energies*" (EEG), implemented in 2000, the promotion of renewable energies should be accelerated. The goal of the regulation is

"to ensure a sustainable development of energy production to promote climate and environmental protection, to lower economical costs, also with the internalization of long-term external costs and to promote the further development of technologies for renewable electricity production." (§1, paragraph 1).

The EEG forces energy suppliers to prioritize renewable energies. Additionally, fiscal incentives for the feed in of renewable energies, also from private households, are given.

This law could act as a role model for environmentally friendly transport – nevertheless, the most important part, a proposed internalization of external costs of electricity production, has not been implemented: A tax for environmental effects of non-renewable electricity pro-

duction has not been levied upon electricity producers. The same is true for transportation: Each attempt to internalize external costs (such as road taxation) was discarded by lawmakers (cf. chapter 3.12 and 4.3).

The electricity supply of the German Railway (DB) is independent of the electricity mix of the rest of the German electricity network. There are no legal requirements for the electricity mix of the German Railway (DB), but the goal of 50% renewables by 2050 is supported (German Parliament, 2011).

3.8 Fuel Improvements

⇨ *Relevant Indicator: F (Emissions of fuels in g/MJ or kg/kg)*

Directive 1998/70/EC sets peak values for lead content to ensure "unleaded" fuel and a peak value for the sulfur content of diesel and gasoline fuels of 50 ppm, with implementation required by 2005. Directive 2003/17/EC even required that "sulfur-free" (maximum sulfur content 10 ppm) fuels are available by 2005.

The implementation into German law happened, referring to UBA (2009f), through the 10th regulation of the *Federal Emission Control Act (10.BImSchV),* which required all fuels in Germany to be sulfur-free by 2003. §1 and §2 of 10.BImSchV require gasoline and diesel fuels to have a maximum sulfur content of 10 ppm and requires the compliance to quality standards of certain DIN norms. This shows that German lawmakers worked very efficiently in introducing more environmentally sound fuels in Germany and complied with Directive 2003/17/EC sooner than necessary.

Emission reductions can be achieved without much effort if the content of the used fuel is changed so that emissions due to combustion are reduced. Ideally, that fuel alternation should take place without changing the engine. An effective way of doing so is the addition of plant oil as "Biofuel". Another possibility of emission reduction through fuels is the lowering of the life cycle emissions of an existing fuel. For both concepts, examples can be found in German law, mostly as implementations of European directives. Directive 94/63/EC sets standards for the maximum emission of VOC´s from storage and refilling of gasoline, which was implemented into German law with the 20th *BimSchV*.

The legislative requirements for biofuels in the European Union (Directive 2003/30/EG) were that by 2005 2%, and by 2010, 5.75%, of the fuel should be biofuel. This directive comes from a time when it was hoped that biofuels would be an easy solution to greenhouse gas emissions from road vehicles. Those numbers have not been achieved (also because of a social equity discussion about biofuels); the real share of biofuels in 2009 was 4.3%, 75% of that biodiesel, 25% bioethanol (EEA, 2011). Germany, regardless, achieved its goal of 6.25% (EEA, 2010a). Directive 2003/30/EG was changed by directive 2009/28/EG about renewable energies and now requires a 10% share of renewable energy sources in transport by 2020.

The fuel quality directive 2009/30/EC binds fuel suppliers to reduce greenhouse gas emissions of their fuels (6% by 2020, independent of the share of biofuels) (article 7a) and to introduce biofuels sustainably. For more details, visit the European Biofuels Technology Plat-

form (www.biofuelstp.eu). Sulfur free fuels are now required (German law already required sulfur free fuels by 2003, see above). The implementation into German law was done through changes in the *BImschG* as stated in §34.1:

"The federal government is empowered to regulate (...) with admission of the Bundesrat (...) that fuels and propellants may only be produced, distributed or imported if they comply to certain requirements for the protection from harmful environmental effects by air pollution." (Author's translation)

This regulation gives the federal government the right to apply environmental quality standards to fuels and is the basis for biofuel regulations. Directive 2003/30/EG was implemented into German law in the " *biofuel Quota Act*" from 18.12.2006 with the goal of an 0.25% annual growth of the biofuel share and a quota of 8% biofuels by 2015. This regulation was changed in 2009 (also because of social aspects of biofuel production and doubts about their sustainability) to lower the biofuel quota to 6.25% in 2010-2014. The changed regulation also implements Directive 2009/30/EC and has stricter regulation than the original directive: A 7% greenhouse gas emission reduction of the fuels must be achieved by 2020 by the fuel companies. Additionally, a *Regulation for Sustainable Biofuels* (Biomasse-Nachhaltigkeitsverordnung) has been introduced and forced fuel suppliers to certify the sustainable production of biofuels. This regulation (§37a-f *Federal Emission Control Act* regulates standards and requirements for biofuels*)* was introduced to ensure a sustainable production of the biofuels used in Germany with respect to climate issues (deforestation for the production of biofuels) and social issues (food security). §37d.1:

"The federal government is empowered to prescribe that biofuels are only (...) taken into account if it is verifiable that certain ecological and social standards as well as standards for the protection of natural habitats have been fulfilled during the production of the biomass and if the biofuel shows a significant greenhouse gas reduction". (Author's translation)

In these regulations we see that the discussion about the environmental impact and social implications of biofuels lead to a modification, but not a withdrawal from the goal of the federal government to have a leading role in biofuel implementation in Europe. The latest development is the decision of the federal government from 28.10.2010 (SPIEGEL, 28.10.2010) to Directive 2009/30/EC, which requires the introduction of a fuel with 10% bio-ethanol (E10) by 2011. For compatibility reasons, the old fuel will still be sold until 2013 at least (ibid.). The decision was implemented as of January 2011 and shows that the federal government continues the implementation of biofuels to lower the carbon impact from road vehicles despite possible negative consequences of this strategy. Because of possible engine damages, many car drivers boycotted the new fuel. Further information is available from MVW (2010).

It can be concluded that Germany is one of the leading countries in the EU and worldwide in setting fuel standards, but has slowed this process in recent years. Fuel standards are closely connected to the use of emission thresholds, which combine fuel specific emission values and fuel consumption and are analyzed in the next chapter.

3.9 Emission Thresholds

⇨ *Relevant Indicator: CO_2 and air pollutants - Emissions in g/km*

Emission thresholds and standards are probably the easiest and most convenient way for law to lower the emissions of vehicles: Regulations like this can be easily controlled and offenses can be punished based on the causer principle. Nevertheless, there are reasons speaking against overly strict emission values: Increasing prices and lowered attractiveness for the local economy as well as problems for automobile manufacturers may be the results of very stringent regulation. An overview over German emission thresholds is available from UBA (2009f) and UBA (2010c).

Road vehicles*:*

The most important regulation for motorized vehicles are the emission limits for newly built vehicles, which are directly set by the European Union in their EURO-norms and are directly implemented as national law. These norms are only valid for newly built vehicles – the promotion of these new and more efficient vehicles usually happens via fiscal measures such as the vehicle tax. Covered vehicle classes in the Euro norms according to UBA (2009f) are passenger cars and small trucks, motorcycles, heavy trucks and coaches, tractors, construction machines, diesel locomotives, small Otto motors and sport boats.

Category	Date	Regulation	NO_x	Hydro-carbons	NMHC	CO	PM
Diesel							
Euro 1	7/1992	91/441/EEC, 93/59/EEC	-	-	-	2.72 (3.16)	0.14 (0.18)
Euro 2	1/1996	94/12/EC, 96/69/EC,	-	-	-	1	0.08
Euro 3	1/2000	98/69/EC,	0.5	-	-	0.64	0.05
Euro 4	1/2005	98/69/EC, 2002/80/EC	0.25	-	-	0.5	0.025
Euro 5	9/2009	2007/715/EC	0.18	-	-	0.5	0.005
Euro 6	9/2014	2007/715/EC	0.08	-	-	0.5	0.005
Petrol							
Euro 1	7/1992	91/441/EEC, 93/59/EEC	-	-	-	2.72	-
Euro 2	1/1996	94/12/EC, 96/69/EC,	-	-	-	2.2	-
Euro 3	1/2000	98/69/EC,	0.15	0.2	-	2.3	-
D 3	1/2000	§48 StVZo	0.17	0.14	-	1.5	-
Euro 4	1/2005	98/69/EC, 2002/80/EC	0.08	0.1	-	1	-
D 4	1/2004	§48 StVZo	0.08	0.07		0.7	
Euro 5	9/2009	2007/715/EC	0.06	0.1	0.068	1	0.005*
Euro 6	9/2014	2007/715/EC	0.06	0.1	0.068	1	0.005*
*** = for direct injection engines**							

Table 4: Emission thresholds in g/km for passenger cars according to different Euro norms

For vehicle tax reasons, the norms D3 (which provides limits between Euro 3 and Euro 4) and D4 (limits between Euro 4 and Euro 5) were introduced as intermediary norms for gasoline vehicles in Germany. An overview of the thresholds for passenger cars is displayed in Table 4. In §48 StVZo, emission classes for the different vehicle types based on the Euro norms are set while the *Vehicle Admission Regulation* FZV, §11a uses this classification for the approval of vehicles in Germany. Newly built vehicles must comply with the latest Euro norm. We see that Germany, after introducing the additional emission standards D3 and D4 restricted its emission regulation to the implementation of the Euro norms.

Railways:

Emission regulations for locomotive engines only exist for diesel-powered locomotives. Directive 97/68/EC (which was expanded to regulate railway engines by directive 2004/26/EG), Annex 4.1.2.4 sets emission thresholds for propulsion locomotive engines, and this directive has been implemented into German law in 28.BImSchV. Efforts by German lawmakers for an implementation of more stringent standards could not be observed. An overview of the emission thresholds is given by UBA (2007a). In 2005, 43.5% of the railway line kilometers was not electrified and thus served by fossil fuel trains (UIC, 2007). UBA (2010), p.58, however, states that only 16% Diesel power is used. Therefore, only a small part of railway emissions are regulated, since electrical railway service also (partly indirectly) emits air pollutants.

Emission standards for road transportation are mainly regulated by EU directives that were implemented into German law; although some additional standards such as D3 and D4 have been introduced by Germany in recent years no more specific regulation was implemented. Railway emission standards are only available for diesel locomotives.
An emission source that is not widely known but increasingly important are the emissions from passenger car air conditioning systems.

3.10 Combating Air Conditioning Emissions

⇨ *Relevant Indicator: CO_2 equivalent leakage emissions in g/km*

With the increasing use of air conditioning in passenger cars, emissions from the leakage of refrigerants become increasingly important: The most commonly used refrigerant R134a has a global warming potential up to 1430 times that of CO_2. The CO_2 equivalent emissions of air conditioning can exceed 7g/km, an enlargement of 5% of the total car emissions (UBA, 2009g). Consequently, there are advantages to the use of CO_2 as refrigerant (ibid.). Directive 2006/40/EC obliges car manufacturers to use new refrigerants with a GWP of no higher than 150 times that of CO_2 by 2017 (2011 for newly developed cars).

This directive has been implemented into German law in the "*Regulation for the Protection of Climate from the Entering of Fluorinated Greenhouse Gases*" (ChemKlimaschutzV) which additionally regulates the maximum leakage of refrigerants. We see that German politicians, having long known of these emissions and alternative refrigerants, waited for EU legislation to combat this problem. This supports the hypothesis that car manufacturers, because of

their economic importance, are often treated very indulgently.

Air conditioning emissions are combated by an EU directive that has been implemented into German law (ChemKlimaschutzV). A measure with the goal to enhance consumers awareness when purchasing a new car is the CO_2 labeling of car emissions.

3.11 Car Labeling

⇨ *Relevant Indicator: Energy consumption in MJ/km or CO_2 emissions in g/km.*

An important approach to improve awareness of passenger car emissions and to increase purchase rates of environmentally friendly cars is the labeling of cars based on their emissions. Referring to EU directive 1999/94/EC (as successor to directive 92/75/EEC about efficiency labeling), customers must be informed about fuel consumption and CO_2 emissions when buying a new vehicle. This directive was implemented into German law in the "*Passenger car consumption labeling regulation*" (Pkw-EnVKV) in November 2004, which obligates car dealers to inform customers about emission and consumption of cars (detailed information is available from IT Recht Kanzlei, 2010). The information sheet must be attached to the car or right next to it. The dealers also must provide a table comparing the emissions and an information sheet for fuel consumption and emissions of all passenger cars they sell. Additionally, fuel consumption and CO_2 emission must be displayed in all advertising brochures.

A revised regulation was set up in 2011: An obvious, category based labeling will be introduced based on the ration between weight and fuel consumption (ranking from A+ for the best ratio to G for the worst ratio): (n-tv, 2011a). We see that – because of an EU directive – measures have been implemented to inform consumers about CO_2 emissions of new and used cars. This regulation and the revised regulation, however, do not work efficiently, as we will see in chapter 7.1. The Pkw-EnVKV regulates the labeling of cars at purchase and the advertisement of cars.

In the next chapter, regulation possibilities that are not (yet) covered by German federal law will be introduced and assessed for their mitigation potential.

3.12 Planned or Proposed Future Regulations

In this section, regulations that will be introduced in the near future or have been discussed are presented. These regulations are not part of German law yet, so no assessment of their effectiveness will be conducted – still, it will be assessed if the German Federal Government has perhaps failed in not introducing a regulation that might be beneficial for sustainable transportation. First, a possible mandatory introduction for particulate matter filters in diesel vehicles is discussed.

3.12.1 Particulate Filters in Diesel Vehicles

Particulate matter emissions of diesel cars are a big problem for human health (EPA, 2010), but the installation of a diesel filter can reduce PM emissions by 98% (kfz-auskunft.de, 2010).

Environmental organizations have for a long time demanded an obligatory implementation of these filters, which was opposed by car manufacturers until 2004. In this year, a non-binding agreement was achieved with the federal government (Wirtschaftswoche, 14.7.2004) in which the car manufacturers promised the implementation of a PM filter for all new cars by 2009. Evidently, the federal government wanted to avoid harming the car manufacturers by regulating this issue. This promise, regardless, has not been kept: In 2009, around 20% of the new diesel cars did not yet have a filter (monstersandcritics.de, 2.4.2009). Aside from the green party (Green party Flensburg, 2008), no neither German party nor the government currently sees a need for the obligatory installation of PM filters. There are, however, tax reliefs on cars with a diesel particle filter and the federal government promotes the retrofitting of cars with the installation of a particle filter. Current emission and air quality statistics can be found from UBA (2009h). We see that the German Federal Government, in accordance with other actions, tries to unburden car manufacturers and to promote environmentally friendly technologies through methods other than regulation. Particle filters are already a common property of many new diesel cars and are financially promoted by the federal government but are not mandatory for new cars.

In the next chapter, a major object of dispute in German politics and society is going to be discussed: A general speed limit on German highways.

3.12.2 Speed Limits on Highways

The energy consumption of a vehicle increases quadratically or even cubically with speed, as shown in a paper from the University of Leeds (Ferreira, 1982). More information about the dependency of pollution emissions on speed is available from EEA (2007), p.57. Germany is the only country in the world without a general speed limit, even though fuel consumption and, therefore, the running costs of passenger cars rise with driving speed, without considering security issues. Thus, regulations but also awareness raising about speed reduction and the connected financial savings have a high potential for emission reduction.

According to UBA (1999), 9% of CO_2 and 16% of nitrous oxides emissions could be prevented on highways if a general tempo limit of 120 km/h was introduced. Referring to Greenpeace (2011), one third of all vehicle kilometers in Germany are driven on the highways, and there is no speed limit on two thirds of these kilometers. Another aspect is the improved safety: 20-37% of all lethal accidents could be prevented with this measure (ibid.). Moreover, the most efficient speed with respect to the maximum transport amount per time is 80 km/h (Monheim, 2011).

Additionally, car manufacturers would be encouraged to downsize their automobiles, customers would be encouraged to buy less consuming cars; presently, cars have an average maximum speed of about 200 km/h, which would become unnecessary if a speed limit in Germany were introduced. The Federal Ministry of Transport and the German automobile club ADAC disagree: Only 2-3% fuel could be saved; additionally they argue that people

would, as has happened in the US, still buy fast cars also after the introduction of a speed limit (WELT, 01.05.2007). A speed limit is a measure against which major protest is to be expected. Unlimited speeding is a sign of freedom for many Germans, the majority of cars built in Germany are designed for fast speeds. Additionally, the "speeding tourism" of many foreigners in Germany is an economic factor as well. The only possibility for the introduction of a speed limit in the near future is a regulation by the European Union, which is not considering such a measure at the moment (Autobild, 28.03.2008). A speed limit on German highways cannot be expected to become reality despite all the safety and sustainability benefits it would bring: Any party that would make a serious attempt of implementing such a regulation is in danger of committing political suicide. A positive development is the implementation of emission thresholds for passenger cars by 2012.

3.12.3 CO_2 Emission Threshold for Passenger Cars

The car manufacturers successfully managed to prevent a legal regulation of CO_2 emissions of new cars. They voluntarily agreed to reach an average emission of 140 g/km by 2008, but did not keep this promise: Average emissions of new cars in Germany were 165 g/km in 2008, 155 g/km in the EU (UBA, 2010). Hence, the European regulation 443/2009 was implemented, which set the goal to 120 g/km for 2012. With certain exemptions and accountancy for other innovations and fade-ins, 137 g/km must be achieved by 2015, which is a very weak standard and practically gives the car manufacturers 7 more years for a reduction to around 140 g/km. A (legally not binding) goal of 95 g/km was set by 2020. However, this is goal is set relative to the weight of the vehicles, so that no incentives for smaller vehicles are given. Apart from that, there are currently no suggestions about the implementation of a CO_2 emissions threshold for Germany, which may also be due to the fact that car manufacturers have a strong lobby here.

It can be concluded that it is certainly a success that a legally binding EU wide regulation (not a directive, though) was implemented. Still, many exemptions have been made and it remains unclear if this regulation (which is certainly the most important single regulation for the reduction of transportation emissions) is sufficient to make Germany achieve its goal of 20% reduction in transportation emissions by 2025 (UBA, 2007).

Although it is a very important and effective way to reduce passenger car and other vehicle emissions, no regulation setting concrete emission thresholds has been introduced by the German Federal government. The present EU regulation does not set ambitious standards. More movement can be seen in another topic: The promotion of long distance buses.

3.12.4 Promotion of Long Distance Buses

Presently, long distance bus lines, although a cost-efficient and emission-reducing alternative to car or railway travel have a share of only 0.1% of German transportation (Deutsche Bank Research, 2010). The reason is that an old law from 1931, which was implemented into the

Passenger Transportation Act (PBefG) after the Second World War, prohibits the implementation of bus lines that compete with existing railway services:

§13 Abs.2,2b: "The permit for railway, obus or bus line service with motor vehicles will not be given, if public transportation interests are harmed, especially if the service would not provide significant improvements compared to the already existing railways services." (Author's translation)

This law gives the German Railway (DB), which also runs almost all of the existing long distance bus lines, an almost exclusive monopoly. This monopoly was established when the German Railway (DB) was owned by the German state and public transportation was planned to be monopolized under the umbrella of DB (Spiegel, 30.5.2010). Since the German Railway has been privatized, however, this monopoly is no longer sensible.

Therefore, proposals have been made to eliminate this regulation and open long distance bus lines to a free market. Analysis shows that a market share of about 5% could be achieved (Deutsche Bank Research, 2010). This study also claims that no decrease in railways passenger numbers would be expected, but rather a decrease in car use. The current German administration included the liberalization of long-distance bus services in their coalition declaration, and the market will be opened in 2012 (n-tv, 2011). An indirect subsidy is given to the long distance buses services, since they will not need to pay road. For more possible public transport regulations, see the next chapter.

3.12.5 Possible Public Transport Regulations

As proposed by BMU (2009), the German Federal Government has a strong emphasis on public transport promotion. Especially railway transportation is an important part of Germany´s sustainable transport strategy. Aside from the already described emission standards for diesel locomotives, an emission based pricing mechanisms for the reduction of railway emissions (UBA, 2007b) is being considered, which shows that emission reductions in the railway system of Germany are possible and necessary.

A publication of the German Environmental Ministry (BMU, 2000a) states that provisions for better emission standards as well as financial incentives for more efficient local public transit service providers must be given. This is especially important since the EU plans to liberalize the local PT market (which is very much publically regulated in Germany at the moment) with regulation 1370/2007. Information about the legal adjustments that have to be made to implement this EU law into German law can be found in DEMO (2008). Hans Boeckler Foundation (2006) and OEVG (2002) describe how the liberalization of the PT market provides a major challenge to local, half governmental public transport providers, which are subsidized and were never forced to manage economically (further reading: Ewers & Ilgmann (2000)). Consequently, a large resistance to this new law can be observed and it is questionable whether and how German law will be adopted to comply with this regulation (ibid.).

After analyzing proposed or "pipelined" regulations, now for a look at possible regulations

which have not been considered by German politicians yet, but which would be helpful for making German transportation more environmentally sound. At first, measures that would influence driving behavior related emissions are analyzed.

3.13 Measures not Covered by German Law

3.13.1 Eco-driving Trainings and Gear Change Indicator Systems

The driving behavior of drivers has an important influence on fuel consumption of road vehicles is of passenger cars, trucks and buses. According to Carlson et al. (2009), fuel consumption of an aggressive driver can be up to two times higher than with a fuel-saving driving style. As a result, awareness campaigns and training on driving behavior promise to have an enormous potential for making transportation more sustainable and profitable for the driver as well for society. Up to 5Mt CO_2 can be saved by efficient driving (UBA, 1999, p.50). Still, aggressive and fast driving as well as speed starting at signals is not only accepted by society but also promoted by the media through movies and advertisements.

There are many training campaigns for fuel efficient and anticipatory driving by private associations such as NABU (Nature Protection Federation Germany) and the ADAC (German Automobile Club) as well as the Bundesland Rheinland-Pfalz. Nevertheless, there is no federal effort for the promotion of this training or proposals for making this training mandatory. Another possibility of reducing fuel consumption is driving in the highest possible gears (only applicable for cars with manual gearshift). Systems that indicate the point of gear changing hence could reduce fuel consumption. These systems are included in some new cars, but there is no promotion of these systems or a push for making these systems obligatory in the federal government. Only the German Environmental Agency (UBA, 2010) proposes to make these systems mandatory. This shows that the federal government obviously fears that regulations forcing people to change their driving behavior would not be publically accepted. Still, there is a proposal in the EU for their next requirement package to make these gear assistance systems mandatory for new cars (Schwab, 10.3.2009).

Although being a (cost-)effective way of lowering passenger car emissions, mandatory eco-driving trainings and gear change indicators are not being considered by German law makers yet. A much more drastic measure is the licensing of car ownership.

3.13.2 Licensing of Car Ownership / Car Usage Restrictions

A drastic measure of reducing car ownership is the restricted licensing of car plates as, for example, in Singapore, where car registration is only possible for a certain number of highest-bidding participants of a license auction (information: Land Transport Authority Singapore, 2011). Also possible is the restriction of car usage as is already done in some big cities (such as Mexico City, Bogota and Laos, see Cracknell 2000). It could, for example, be announced that cars with a plate number ending with 0 are not allowed to drive on Mondays. Thereby, car ownership as well as car usage can be drastically reduced (despite rebound effects such as

the additional purchase of cars to ensure a trouble-free mobility).This measure is not proposed by any party at the moment and it is questionable whether it would be publically acceptable in Germany. The same can be said about the next possibility, an introduction of regional money.

3.13.3 Regional Money

For the promotion of regional economic cycles, the introduction of regional money is sometimes proposed, which would strengthen local companies and demand (see Kochmann, 2005 for a legal analysis). Besides pilot projects, nevertheless, no efforts in promoting this measure exist. Now, fiscal measures for sustainable transportation are described.

4. Fiscal Measures for Sustainable Transportation

Fiscal measures have a big influence on the demand of goods and services (including transport) and, therefore, can be effective in promoting certain behaviors. With respect to transportation, two main influence possibilities on the federal level are given: Taxes and subsidies.

Based on a definition by the online dictionary "investorwords", a tax is "a fee charged by a government on a product, income, or activity" (WebFinance Inc, 2011). From the many kinds of taxes, the following taxes are important for the topic of this study:

- **Ecotax**: An ecotax or environmental tax is a tax that intends to promote sustainable activities by taxing environmentally harmful activities or products with the hope that environmentally friendly products or activities will be preferred. This concept is called the "Lenkungswirkung" (steering effect) of taxation. The taxes this study treats are ecotaxes, at least partly.
- **Flat tax** describes a taxation at a common rate (WebFinance Inc., 2011), in contrast to the ad valorem tax, which is dependent on the value of the taxed object (e.g. property taxes). A special case is the proportional tax, which grows proportional to the value of the taxed good. Flat taxes are the simplest way of taxing and are used in many different applications.
- **Consumption tax**: A consumption tax is levied at the purchase or sale of goods or products, the most well-known example is the "Value-added tax" (VAT), which is added to a product or service at each stage of production and is 7/19% (reduced / full tax) in Germany at the moment (EM RIC Internet Consulting, 2011). The VAT is known to hit lower-income households harder than high-income households, because they have to spend a higher share of their income for the purchase of necessary goods such as food and also transport. Another example are excise taxes, consumption taxes on special (often luxury) goods such as tobacco, alcohol or energy.
- **Tolls:** A toll is a fee for the use of transportation facilities; different concepts such as flat and proportional taxation are possible here.

One of the most important tax theories in the concept of welfare economics is the "optimal tax theory" (University of Berkeley, 2004) which studies how to create taxes such that they are least distorting and cause minimal inefficiency. The ideal tax in the economic welfare theory

without market failure causes no efficiency loss and is called “neutral tax“. The idea of the optimal tax theory is to minimize deadweight losses (DWL), which can be described as “what would be gained if distortionary taxation was replaced with a non-distortionary (...) tax raising the same amount of revenue“ (ibid.).

Another very important concept of environmental taxation is the concept of external costs or externalities, which can be positive or negative. Here, negative externalities are considered: the price of a good is lower than it should be considering social costs and benefits.

External costs should be internalized to ensure a working market. One method of doing this is the so-called pigouvian tax: According to the first paradigm of the welfare economics, any competitive equilibrium leads to a pareto-efficient allocation of resources (Marginal Revolution, 2007). A market failure can occur if the price for a good is lower than its actual social cost, which is true if external costs occur (which is the case with car traffic as will be shown). To counterbalance this market failure a pigouvian tax can be levied for the difference between actual costs and market costs of a product (UNDP, 2011). With this internalization of external costs, the price for a product is corrected.

In practice, however, the implementation of a pigouvian tax is very difficult, since a flat tax is inappropriate for the behavior of many market participants with individual marginal costs – it would require an individual tax for each market participant. Additionally, a pigouvian tax requires total market information and the knowledge of the optimal price, which in reality is never known (ibid.).

Although the internalization of external costs is a difficult concept when it comes to implementation, it remains true that external costs provide a welfare loss and promote the destruction of the environment, where they make environmental harmful behavior cheaper than it really is. Consequently, they must be eliminated to the greatest extent possible.

Taxation must be balanced between the optimal tax rate which minimizes economy distortion or deadweight losses as proposed by the “optimal tax theory“, and the internalization of external costs with the goal of the maximization of the environmental benefit of taxation. This two-fold goal of taxation is described by the “double dividend hypothesis“. With respect to the environment, passenger cars cause external costs of three kinds:

1. Quantifiable external costs for noise disturbance, pollution removal, accidents and more
2. Costs for the adaptation to climate change and costs for the removal of damage caused by climate change, which are created by the emission of CO_2 and other greenhouse gases. The quantification of these costs is still under discussion.
3. Non-quantifiable social costs such as loss of biodiversity, lower environmental quality, and other damages that are not monetarily quantifiable.

Estimations for these costs differ greatly. While BUND (2004a) estimates that the external cost of passenger cars are 71 billion Euros and 7.6 ct/km, Pethig (2009) claims that most of the external costs are already internalized and that only 1.7 ct/vehicle-km remain as external costs. Infras / CE Delft (2007) give an excellent overview of the calculation of the costs:

Around 80 billion € of external costs are created by national transportation in Germany, of which are 97% caused by road transport.

No study, however, doubts that the external costs of passenger cars are 3-4 times higher than those created by trains or buses. This shows that passenger car transportation creates a huge market failure.

These estimations do not take into account the costs of CO_2. (UBA, 2005a) sets 70 €/ton as the cost of CO_2 while other sources talk about 20€ - 100€. At the German emission stock exchange in Leipzig, one ton of CO_2 is currently traded at around 10€ (http://www.eex.com, November 2011).

UBA (2005a) concludes that the external costs of passenger cars represent 12.4 ct/vehicle-km. The costs for the driver of the car are around 15ct – 40 ct (see the example by auto-kostencheck.de), which means that the price the customer pays is 24-45% lower than the real costs of car transport. Currently, these external costs are mainly paid by the government and in the end by the taxpayer (pollutee-pays principle). If every taxpayer would contribute the same amount to the external costs, this system would be very just. Since not every German citizen is a car-driver, the "polluter – pays principle", which means that the polluter (here: the car driver) should pay for the costs he creates to society, is violated. Baum et al. (2009), a study for the European car industry, however, argues that the "cheapest cost avoider principle", (which says that the party with the lowest avoiding costs has to bear the burden of external costs), is more beneficial for society.

Environmental subsidies work in a different direction: Instead of the sanctioning of an environmentally harmful behavior, an environmentally sound behavior is rewarded with a monetary advantage, be it direct (for instance with a subsidy for the use of public transit) or indirect (with a tax relief for efficient cars, for example).

However, there are also environmentally harmful subsidies such as the commuter subsidy that promotes the use of personal cars for commuting. Here, a removal of the subsidy can promote the use of more efficient transport modes and lower the environmental externalities of transportation (in this case, the spread of suburbs).

While subsidies can indeed promote certain environmentally friendly technologies, companies and behaviors, they have a number of economic, political and environmental disadvantages and, therefore, should be used as little as possible (Kortmann, 2004):

- Competiveness: The use of subventions often lowers the need for innovations and price efficiency and hence lowers competiveness and the introduction of new technologies. Therefore, e.g., the promotion of electric mobility could prevent the development of a cost-efficient solution and could lead to an increased purchase of conventional cars.
- Binding of resources: The promotion of certain technologies (e.g. electric mobility) binds resources, which might be more effectively used for different ways to achieve the same effect (promotion of non-motorized transport modes). If a certain subsidy leads to a non-optimal behavior (e.g. the promotion of solar panels in Germany, which is extremely successful but not the most efficient way of promoting sustainable

electricity production: Sueddeutsche, 2011), it is hard to set a different course.

- Prohibition of competition: A certain way to achieve an environmental goal is preferred before others. Consequently, other actors (such as environmental organizations) are hindered in their efforts for different ways to achieve a goal. Moreover, big companies are favored in comparison to small, but maybe more innovative players.

Now we proceed to the most important influence possibilities of fiscal measures on sustainable transportation in Germany, whether direct (taxation) strategies or indirect strategies (removal of harmful subsidies).

4.1 Fuel Taxation

Fuel taxation is a consumption tax and, more specifically, an excise tax (Forsberg, 2002) that is imposed on the sale of fuels. Fuel taxation in most cases is a flat tax, the price P for one liter of gasoline or other car fuel is increased by the tax T: $P_{new} = P_{old} + T$.

Referring to Pethig (2009), the gasoline tax is *"nearly the perfect pigouvian instrument for mitigating global warming"*, since it correlates almost perfectly with the CO_2 emissions from a car – the more kilometer a car is driven, the more fuel tax has to be paid. As a result, the fuel tax theoretically promotes the decreased use of cars, fuel-saving driving behavior and the purchase of lower-consuming cars (as also described by (Transportation Research Board, 2006)). Additionally, an individual tax is levied on each participant in car transportation, which is a prerequisite for a working pigouvian tax.

With a higher fuel tax, congestion and thus external costs can be reduced (which extends the effect of the taxation), people are encouraged to reside nearer to their working places and malls and the tax money can be spent for an improvement of the transport infrastructure.

In practice, though, the effects are often lower than expected: Although Victoria Transport Policy Institute (2010) projects a reduced mileage and improved fuel efficiency that sum up to an emission reduction of 0.5-0.9% if fuel price increases by 1%, Cascade Poliy Institute (2009) describes that the correlation of fuel prices and "Vehicle Miles Travelled" is negative, but weak. In the US, fuel prices grew by 117 % between July 2004 and 2008, the miles driven were reduced by 4.2% only. Smith (2000) states that

"the fact that there is some response to increases in price, even though it is small, does imply that there will have been some reduction in miles driven, especially with such a high tax on petrol, but it is impossible to tell whether the price of petrol now adequately reflects the social costs of road transport" .

Additionally, as West (2005) describes, fuel taxation is questionable in terms of social equity: Since low-income households (in the US) have more fuel-intensive vehicles and spend a higher percent of their income on fuels, fuel taxation hits them harder than high-income households. This effect is partly mitigated by a small vehicle ownership and an increased responsiveness on taxation. If there is, however, no possibility of decreasing car usage, this tax results in social inequity.

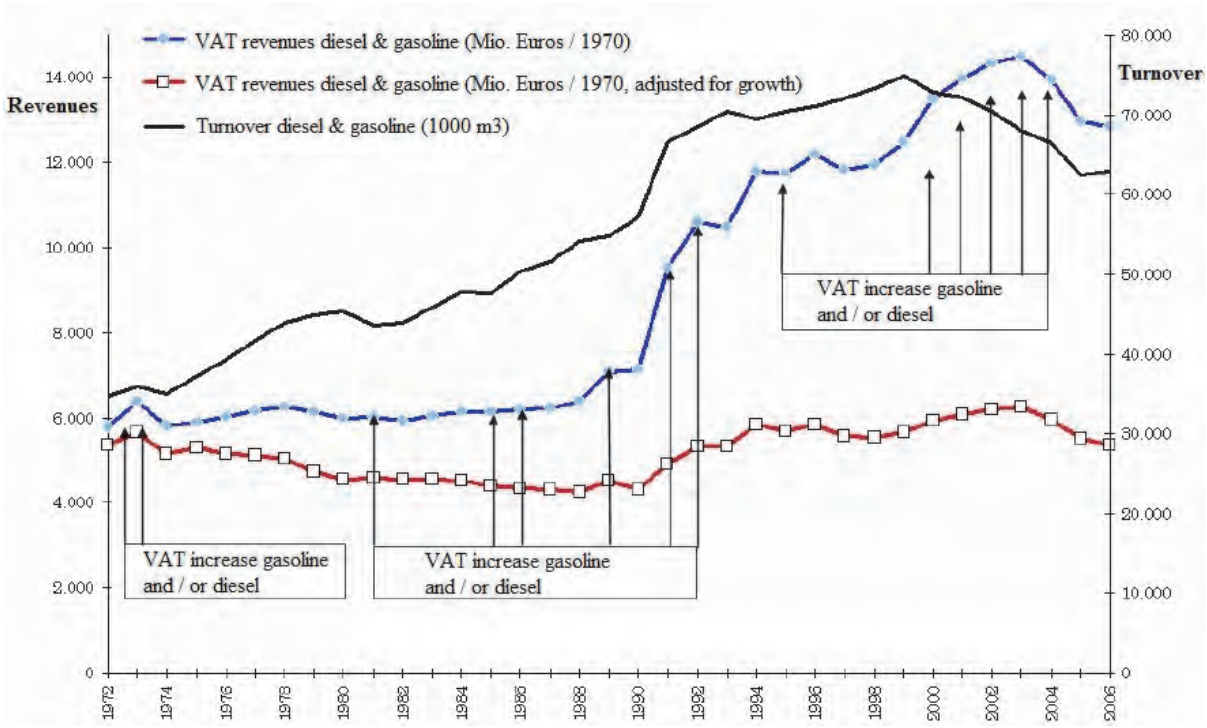

Figure 8: Diesel / gasoline VAT revenues and turnover, adapted from (Thoene, 2008)

Furthermore, the fuel tax gives room for "fuel tourism", which is especially popular in Europe: If fuel taxation is unequal in neighboring countries, car drivers from the more expensive country refill their cars in the cheaper countries. The losses for the German federal state alone from fuel tourism in Austria add up to 2.4 billion € (Strobl, 2010).

The fuel taxation in Germany has existed since 1930 and is a flat consumption tax called "energy tax" since 2006. At the moment, the tax on gasoline is 0.6545 €/l, the tax on diesel 0.4704€/l, the taxes for LPG and CNG are up to 60% lower to promote the use of these vehicles (Federal Ministry of Finance, 2009). More tax reliefs exist for diesel fuel that is used by agricultural vehicles. The tax reliefs on diesel fuels can be explained by the lower fuel consumption of diesel vehicles – though diesel vehicle have other negative environmental impacts, for instance the emission of particulate matter (PM): (Greepeace, 2008). Therefore, the lower tax on diesel fuels is often criticized as a hidden subsidy for the freight transportation sector, in which diesel is often used for trucks.

Since fuel taxation in Germany is subject to VAT (19%), around 50-64% of the fuel price are paid as taxed to the federal government without earmarking. An exception is the so called "Ökosteuer", which was introduced by the socialist-green government in 1999 and increased the fuel tax dramatically (by 15.3 Cent by 2003), with the goal of promoting public transportation and fuel efficient driving behavior as well as the reduction of overall car usage. The revenues created by this tax are used to stabilize the pension insurance system and thus work as "revenue recycling" to lower the marginal costs of labor. According to Rappen (2006), a small part now is also used for road construction and the promotion of environmentally friendly technologies. Referring to Thöne (2008), it may very well be that further increases in fuel taxes lower car mileage, since the past tax rises lead to lower revenues (cf. Figure 8). A different approach is a direct tax on the ownership of a car.

4.2 Car Taxation

Car taxation can be seen as an excise tax levied on the possession and use of a passenger car. Depending on the country, the payment of the tax is either necessary to be able to possess a car (e.g. Germany) or to use it on public roads (e.g. UK).

A car tax can be levied on the purchase of a car or, more commonly, on the possession of a car. Depending on the factors of the car tax, different regulations possibilities exist: Most commonly, the strength of the engine (and thus indirectly the fuel consumption) is one factor, certain emission values, vehicle improvements (such as soot filters) or standards can be other factors. With these factors, the purchase of fuel-efficient and less-emitting cars is promoted. Other possible factors are the value of the car (in which case, the tax is an ad valorem tax) or the age of the car (to promote the purchase of new, more fuel-efficient cars). Car taxation enhances car prices, a measure that has an elasticity of 0.4-1 (VTPI, 2010), which means that a 1% vehicle price increase reduces vehicle ownership by 0.4-1%.

The advantages of a car-based taxation are that it levies taxes also on those cars that are not used, but cause costs to society for parking areas and registration. It provides an income for the state even if refueling happens in a neighboring country (fuel tourism) and, most importantly, it offers the possibility to give tax relief to people in need and disabled persons, and give financial incentives for the purchase of more fuel efficient cars. Disadvantages are the high administration effort necessary to ensure the collection of the tax and the injustice that a hardly used car is levied with the same tax as a car that is often driven.

In Germany, the car tax was the responsibility of the German states before the 1st of July, 2009 (which means that the tax was regulated by the federal state, but the administration was done by the states and the revenues went to the states) and was calculated based on the EURO emission categories and the cylinder capacity of the car. Since this date, the federal state is in charge for the car taxation and receives the revenues: For all cars that apply for permission, the car taxation is calculated according to their cylinder capacity, and additionally, a fee for every gram of CO_2 that exceeds the limit of 120g/km is levied. An exception is electric cars, for which no tax is levied for the first ten years (FOCUS, 2011). For diesel cars without particulate filters, an additional fee is levied. Hence, the new car taxation in Germany can be seen as a "standards and price-approach" with the established goal of achieving certain emission standards for new passenger cars.

The standard of 120g/km will be decreased to 110 g/km by 2012 / 2013 and to 95 g/km by 2014 according to the EU regulation 443/2009, which the new law is a response to. There are possibilities for tax reliefs for cars with special purposes such as police and medical cars and for disabled people.

By making car taxation dependent on the CO_2 emissions, the federal government hopes to promote the purchase of lower fuel consuming vehicles and to achieve the EU threshold (regulation 443/2009) of 120 g/km (EC, 2010). A possible future regulation, which is not (yet) applied in Germany, is the taxation of road usage.

4.3 Road Taxation

A taxation levied on the use of certain roads is often suggested as Pigouvian tax for the internalization of external costs (Gwilliam & Shalizi, 1996) and is already used in many countries. In most cases, motorways or city centers are subject to taxation (see the "London City Congestion Charge"; (Hartwig & Marner, 2005)) The introduction of a road taxation for passenger cars is not a new concept and has been discussed for more than a century (DiW, 2009). Until now, the implementation of such a tax was accompanied by major difficulties: In many European countries "Vignettes", toll stickers, are used – this system, however, requires cars to stop and buy a vignette; additionally, enforcement is very difficult. Hence, new systems are developed: In many cities and countries such as Austria and Germany, radio transmitters with the possibility of an electrical control and payment have been introduced and could be used to implement a road tax at least for the major motorways.

By internalizing external costs, road taxation enlarges the marginal costs for car driving and gives incentives to cancel unnecessary trips or to use public transportation. Jakubowski & Lorenz (2008), however, argue that road taxation would only make sense as a congestion charge at high traffic volume to avoid congestion, which is connected with high social costs. If road taxation is levied at times of low traffic volume, unnecessary costs are created for society. Jakubowski & Lorenz (2008), therefore, suggest the implementation of a two-step model of a (low) annual fee for the use of certain roads plus a traffic-volume dependent fee. Hartwig & Marner (2005) introduce the possibility of an emission based tax that charges road use based on distance and emissions and thus gives incentives for the use of fuel efficient cars and prevents unjust charging of fuel efficient cars that would otherwise have to pay for the external costs of high-polluting cars. Technically, a tax like this is possible when radio transmitting traffic surveillance systems exist: A chip inside the car would provide technical and emission information to the system that would charge the car user accordingly. Of course, it must be ensured that the data collected in connection with the toll collection is used responsibly.

The impacts of road taxation cannot be easily estimated and very much depend on the kind of taxation and time of day. In average, studies collected by VTPI (2010), show an elasticity of 0.3-0.5, which means that 10% road taxation increase induce a 3-5% traffic reduction.

A very successful example is the London congestion charge, which is reported to have reduced car traffic by more than 30% in inner London, of which 50-60% is shifted to public transportation (Transport for London, 2006).

Baum et al. (2008) state that the implementation costs of these systems for EU-27 would exceed 33bn € with annual costs of 22bn €. The study also warns of exploding inflation (+2-3%) and job losses of 100,000 jobs in the EU. Similarly, the European Road Federation (European Road Federation, 2009) emphasizes the economic harm and social injustice of a road tax in their opinion. The DiW simulation (DiW, 2009), however, sees no negative economic impacts of a road tax: The negative effects on the automobile and logistic industry are expected to be compensated by a growing public transport and railway logistic demand. Baum et

al. (2008) argue that road charging is socially unjust since low-income households would have to pay a higher percentage of their income on road taxation. DiW (2009) replies: A small revenue for low-income households eliminates social inequity while keeping the incentives to use more environmentally friendly transport modes. Another negative effect of road taxation is the so called "shunpiking", which describes the avoidance of tolled roads for the use of local roads without charge and causes congestion and increased noise and emission pollution for the residents near these roads.

In Germany, there is no road taxation for passenger cars; the system "toll-collect", an electronic system for toll collection from heavy trucks using German high-speed motorways, however, has existed since January 1st, 2005. An expansion of this very expensive system to passenger cars is doable, but for political reasons, no political party has made a serious attempt of introducing road taxation for passenger cars. Although the possibility is discussed, the social pressure of car drivers and lobbying by car manufacturers and automobile clubs have suppressed any attempt until now.

To be a pigouvian tax for the internalization of the external costs of car transportation, possible road taxation needs to be in the category of 12.4 ct/km (cf. the introduction of chapter 4). Even if the argument of ACAE is right and some costs such as the congestion costs are already partly internalized, the tax would have to be in the area of at least 5 ct/km. According to a study by ADAC (autoblog, 15.6.2010), this amount would create revenues of 25 billion € per year (which are partly compensated by decreasing revenues from fuel taxation because of decreased mileage) while creating costs of 1.5 billion € for the society. An estimated 25000 jobs would be lost in Germany, and the average car driver would have to pay 700 € per year for road taxation, referring to the study.

The negative effects of this tax - which still insufficient since it does not cover the external costs of 47 billion € - are compensated by an increase of the welfare benefit (because of the disappearance of DWL). Additionally, economic growth in other industrial areas such as public transport and e-banking and other applications, which will can done at home when transportation becomes more expensive, can be expected. Additional positive effects include the promotion of regional economic cycles and, if road taxation is based on car emissions, a growing demand for fuel-efficient cars.

Herzog (2011) provides detailed information on different possible road taxation systems for Germany, the main two categories are a *static* taxation and a *dynamic* taxation. The static taxation would require a permit from all car users to use the motorways for a certain time. This approach is easy and would require low administrative costs. However, it is not very environmentally friendly, as it does not charge taxes based on mileage and fuel consumption of the cars. The dynamic approach, an electronic tax, would be levied based on the properties of the cars, mileage and the current traffic situation. This approach would be environmentally friendly, as it differentiates according to fuel consumption and mileage, but would be complicated to implement and would require high administrative efforts.

Presently, many political debates take place, about whether or not an increase in the fuel

tax could replace the car tax or a possible road taxation (Kammholz, 2011, Focus, 2011).

A relatively new approach is a cap-and-trade system similar to the European emission trading system.

4.4 Cap-and-trade System for Individual Traffic

The European wide cap-and-trade system for heavy industries limits the amount of the total emissions and allows for a trade of emission certificates. By introducing an ambitious cap for emissions, an effective instrument for the reduction of CO_2 emissions could be introduced.

The German Environmental Agency evaluated the possibility for a cap-and-trade system as early as 2005 (UBA, 2005) and concluded that such a system is possible and sensible within certain boundaries: As Sturm & Braun (2009) shows, the down-stream approach (emission trading on an individual car user basis) is connected to huge implementation and running costs. Hence, an up-stream approach, based on fuel importers and producers, or a middle-stream approach, based on fuel stations and car producers, could be successful (Flachsland, Brunner, Edenhofer, & Creutzig, 2011). The liberals, a party in the German parliament, have already shown their interest in an implementation (Energieblog, 2007).

Fiscal instruments do not only include the use of taxes; also, the implementation of subsidies for the promotion of sustainable mobility (behavior) and the removal of subsidies that promote environmentally harmful behavior should also be included.

4.5 Subsidies

4.5.1 Alternative Fuels and Car Concepts

The German Federal Government subsidizes research about alternative and more environmentally friendly car concepts and fuels. As focus, the concept of electric mobility and LPG / XPG propulsion is promoted and subsidized:

For natural gas, the energy tax is massively reduced: One Megawatt hour of natural gas is taxed with 13.90€ (Autobild, 2006), just 20% of the tax for gasoline. This subsidy is guaranteed until 2020 (Stiftung Warentest, 2003). Therefore, natural gas is 60% cheaper than gasoline (Autobild, 2006), which represents a massive subsidy for natural gas, which emits less CO_2 and other harmful substances compared to gasoline (Austrian Environmental Ministry, 2008). Along with some local governments, the German Federal Government subsidizes the conversion of a gasoline car into a natural or liquid gas powered car for tradesmen (Autotipps.net, 2011).

As second most important subsidy, the promotion of electric mobility must be mentioned: If an electric car is purchased, the owner does not have to pay car taxes for five years (Elektroauto-fahren.com, 2009). The research for electric mobility and hydrogen cars was promoted with 500 million € in the financial crisis (ibid.). Still, the subsidies for electric mobility are low compared to other countries (ibid.). Consequently, additional subsidies are planned: The tax relief for electric cars is to be expanded to ten years, and the research subsidy will be

expanded to 1billion €. Additionally, prioritized parking is considered as possibility to promote electric mobility (FTD, 2011) as well as other smaller tax reliefs (Elektroautofahren.com, 2009). In addition, the establishment of a charging net may be subsidized in the future (TZ, 2011). A third subsidy, which because of its larger share of promotional and educational measures is listed under "soft measures", is an increased financial promotion of bicycling infrastructure: Around 100 million € is spent directly from the Federal Government annually on bicycling infrastructure (BMVBS, 2002). Additionally, some parts of GVFG subsidies for local communities (in total 1.68 bn €) are spent on bicycling related infrastructure. Further subsidies are spent for public transportation.

4.5.2 Public Transportation

The subsidizing of public transportation is split into two parts: The promotion of regional public transit and the promotion of long-distance rail transit.

The provision of regional public transportation is technically the task of the "Bundesländer" and the local communities. However, as regional public transport in most cases does not cover its costs and the communities lack financial resources, the Federal Government still gives many subsidies. The most important according to Infras (2007) are (data for 2008):

- Direct subsidies for regional transportation railway projects (200 million €)
- Subsidies in compliance with the "law for the financing of local transportation" (GVFG) (668 million €)
- Other subsidies for local railways (35 million €)
- 2 billion € as "compensation of fare losses" for local transport service providers (as only one third of the costs is covered from transport fares: Bölke, Denzin, Huckestein, & Specht, 2003)) plus 4.2 million € for research projects
- 132 million € as subsidies for the German Railway (DB) for local public transport construction works
- 6.7 billion € of "regionalization means" in compliance with RegG do not technically count as subsidies for communities, but in fact are
- 200 million € for tax reliefs for local transport service providers
- Around 1 billion € are paid as indirect subsidies for the users of public transport, the main part for a lower VAT
- TU Dresden (2004) adds that 1.4 billion € are paid as compensation for lower fares for disabled persons and apprentices (based on §45a *Passenger Transportation Act* and §6a *General Railway Act*)

Including the regionalization means, a total of 12.4bn € are given to local transport providers. The second main subsidies are paid for the provision of regional and long-range rail transport, mainly to the former monopolist German Railway (DB)

- To the "DB Netz AG", the provider for the railway net, around 8.8 billion € in subsidies is paid (directly or indirectly), of which around 68% or around 6 billion € can be

accounted for by passenger traffic. Additionally, no ground tax has to be paid by DB Netz. However, around 20% of these earmarked subsidies flow back to the DB as additional benefits, which resulted in investigation by European competition authorities (Frankfurter Rundschau, 2010a). Subsidies are guaranteed until 2020 (Dashconsult, 2006).

- Users of the regional and long-distance railway are given 400 million € each year, as they also profit from the commuter subsidy. (Dashconsult, 2006).
- The regional trains of the DB are subsidized with 4.3 billion € (around 60% of the total turnover), however, part of this money is included in the subsidies for regional transportation (Dashconsult, 2006).

The total subsidies, given to the German Railway (DB) for passenger transportation, sum up to around 10.7 billion €.

The subsidies for the promotion of public transportation are complex and split up into many sub-parts. Still, it is obvious that massive subsidies are necessary to keep the public transport system in Germany running. However, although the direct subsidies for public transportation and motorized individual traffic are similar, the externalities and, consequently, indirect subsidies for road transportation are much higher (compare chapter 4).
Another important subsidy is the promotion of biofuels.

4.5.3 biofuels

biofuels are mostly indirectly subsidized in Germany. An exception is the promotion for farmers that grow biofuels. This promotion (90 million €) is paid by the EU (hence, partly by the German Federal Government), but will be cancelled soon (Handelsblatt, 2008). The tax reliefs for biofuels have been changed several times (BMF, 2008): Until 2004, pure biofuels were not taxed; mixtures of biofuels and gasoline or diesel were taxed like normal gasoline or diesel. From 2004 to July 2006, biofuels and mixtures were actively promoted and released from taxes if the majority of the fuel was biofuel. Since 2006/2007, biofuels have been taxed; the taxation will be raised in 2012, but is still much lower than the taxation for gasoline and diesel. The prescribed share of biofuels in normal diesel and gasoline remains untouched by tax reliefs. As additional subsidies, the use of biofuels for agrarian and forestry purposes and special biofuels such as “Biomass to liquid“ fuels are exempted from tax payments.

One of the major and best known subsidies declared to promote sustainable mobility is the “scrapping premium” from 2009.

4.5.4 “Scrapping Premium“

Because of the financial crisis in 2009 and the negative impacts on the export-oriented car industry in Germany, a “scrapping premium“, officially called “environmental premium“ was initiated by the German Federal Government. For the purchase of a new car and the simultaneous scrapping of an at least nine year old car, a 2,500€ subsidy was given to the purchaser of the car. With a total subsidy of 5billion € and a total number of 1,706,839 purchased cars,

this premium was a huge success (BAFA, 2010), (IFEU, 2009). However, no environmental standards had to be kept for the new car, a fact that was massively criticized by environmental organizations (BUND, 2009). Likewise, as the construction of a car causes a huge amount of emissions (umwelt-blog.net, 2009) and no similar premium existed for more sustainable transport modes such as bikes or public transit (VCD, 2009), the skepticism with respect to the environmental impact of the cars was great.

Given this overview of subsidies that is supposed to make transportation more environmentally friendly, we now move to harmful subsidies and the efforts to remove them.

4.6 Removal of Harmful Subsidies

Subsidies for environmentally harmful transport behavior, whether direct, such as subsidies for commuting by car, or indirect - such as tax relief for diesel fuels -, can encourage unsustainable behavior and eliminate the effects of measures for sustainable transportation.

According to UBA (2008), around 20 billion € is spent on subsidies for environmentally harmful behavior in the transport sector in Germany. OECD (2002) presents a checklist for the identification of harmful subsidiaries.

Not included in the following list is the subsidy for biofuels (cf. chapter 4.5.3), although the environmental impact of the use of biofuels is unclear and very much depends on the origin of the fuels (Withana, 2009). Only biofuels that are socially and environmentally harmless should be promoted with a tax relief (Nabu, 2006). A controversially discussed harmful subsidy is the tax relief for diesel fuel.

4.6.1 Tax Reliefs for Diesel Fuel

The fuel tax on diesel fuels in Germany is 18.4 cent lower than on gasoline (Federal Ministry of Finance, 2011). Around 6.15 billion € were lost to the state because of this tax relief in 2006 (Greepeace, 2008). The tax difference is often explained by the fact that diesel vehicles consume less fuel than gasoline fueled vehicles. However, diesel emits 13% more CO_2, 10 times more nitrous oxides and much more harmful particulate matter (UBA, 2008). The real reason for the lower tax on diesel fuels, therefore, could be seen in the protection of the German automobile and road freight industry.

The EU commission introduced a new regulation, according to which fuel is to be taxed based on energy content and CO_2 emissions by 2023 (Presseportal, 2011), which would cause diesel fuels to be levied with higher taxes than gasoline fuels. The German Federal Government, as well as the automobile industry has announced their intention to fight against this new regulation that would make diesel fuels uneconomical (Zeit, 2011).

In addition to the tax relief on diesel fuels for passenger cars, a tax relief on agricultural diesel from 40c/l to 25.59c/l was announced in 2009 (Finanznachrichten, 2009). Although the German tax on agricultural diesel is still high in comparison to other EU countries, especially France (BMELV, 2011), environmental organizations and the green party criticize this indi-

rect subsidy, as it dampens promotion of energy efficient technologies in the agrarian sector (gruene-mv.de, 2009, UBA, 2010). Around 285 million € are spent on this subsidy each year (Handelsblatt, 2009). A harmful subsidy of similar dimensions as the promotion of diesel fuels is the commuter subsidy.

4.6.2 Commuter Subsidy

In difference to many other countries, commuters in Germany are subsidized with 920€ per year and 30c/km if this amount is exceed for travel from their residence to their working place (UBA, 2008). In 2007, the German Federal Government limited this subsidy to commuting distances above 20km. The German Federal Constitutional Court, however, forced the German Federal Government to return to a regulation without a distance threshold. Around 4.3billion € were spent in 2007 for this subsidy (Die Klima-Allianz, 2011), which is criticized as environmentally harmful by environmental organizations: As it makes longer commuting distances more affordable, it encourages commuters to move into suburbs with low public transit quality. Hence, the use of private cars is promoted (UBA, 2008). Furthermore, the sealing of soils and the destruction of natural resources is accelerated by the spread of suburbs (Köck, 2008). Additionally, the subsidy is limited to 4500€ for the use of public transit, but unlimited if a private car is used (recht-finanzen.de, 2010).

Nevertheless, the German public and politicians want to keep this subsidy, and car lobby organizations even promote an increase of the subsidy (Auto.de, 2011). A similarly harmful subsidy is the flat tax on private use of company cars.

4.6.3 Flat Tax on Private Use of Company Cars

The private use of company cars in Germany is levied with a flat tax of 1% of the original value of the car, independent of the real costs. As this tax is very low in comparison to the wage costs, companies are encouraged to give company cars to employers instead of raising the wages. Environmental organizations see this as very harmful to the environment:

In normal years, around 60% of all new cars sold in Germany are company (Diekmann, Gerhards, Klinski, Meyer, & Thöne, 2011). As they are used as incentives for good employers, many large and heavy cars are used: The average CO_2 emissions per kilometer for company cars are higher than for private cars (167g/km vs. 162 g/km, (Diekmann, Gerhards, Klinski, Meyer, & Thöne, 2011)). Around 75% of the most emitting vehicles are company cars (UBA, 2008). Although financial scientists argue whether this taxation can be called subsidy (UBA, 2008), environmental organizations demand a taxation based on CO_2 emissions to give incentives for the purchase of lower emitting cars (Greepeace, 2008). Estimations for the amount of the subsidy range between 500 million € (ibid.) and 2.9billion € (Die Klima-Allianz, 2011).

Besides these obvious subsidies, a number of sometimes hardly quantifiable subsidies for harmful transportation behavior, especially the use of cars, exist.

4.6.4 Hidden Subsidies

Motorized individual traffic (MIT) causes many costs for society, with not only the construction of roads, but also the construction and maintenance of parking spaces, road cleaning, road illumination and road draining. Additionally, many costs to the police, rescue workers and fire fighters are caused by MIT (VCD, 2011). In this list, the costs for the removal of pollution effects and CO_2 abatement are not even included. According to VCD (2011), around 55 to 85% of these costs cannot be paid by local governments and, consequently, have to be paid by the "Länder" and the German Federal Government. Around 80 million € are spent on research programs for the car industry (Infras, 2010). Around 650 million € are paid for the construction of local road infrastructure and the same amount for public transit infrastructure. Nevertheless, as local communities in Germany are massively subsidized by the Federal Government, Infras (2010) estimates that around 11.9 billion € (around 128€ per person, (ICLEI, 2001)) are paid as indirect subsidies for road infrastructure for local communities by the Federal Government. This number, however, is only a very coarse estimation and not reliable. Referring to VCD (2000), landlords are responsible for the construction of parking spaces for their tenants and have to pay a fee if they do not provide enough parking spots. The tenants will have to pay this fee, whether they have a car or not.

Furthermore, financial aid for local communities is often given based on0 their road length and the number of registered vehicles. By doing this, communities that promote sustainable transport are disadvantaged (Monheim, 2011).

"Allianz pro Schiene", a German lobby organization for rail transportation, estimates that the external costs of road transportation add up to around 97.3 – 137.5 billion € annually (!), (Hirte, 2008).

We can see: Road transportation as the dirtiest transport mode is massively subsidized by open and hidden subsidies. Removing or reducing these subsidies or internalizing these costs to the car drivers could help in making car transportation less attractive and induce a modal shift. The next chapter deals with so-called "soft" measures for the promotion of sustainable transport.

5. Soft Measures for Sustainable Transportation

As described in chapter 1, behavior changes are necessary for sustainable transportation in Germany. The theoretical models introduced showed that the attitude, the perceived social norms and the self-control are key factors for transport behavior. “Soft” measures can help changing attitudes and – if introduced consequently – even social norms. Additionally, they are necessary to exploit the potential of hard measures, as described by Otto (2010).

Soft measures for sustainable transportation in Germany mainly take place in local communities and cities. Only a very few measures are implemented at federal level. However, as the German Federal Government and its ministries finance many projects, a number of projects can be seen as (at least partly) federal measures.

Still, very few “big“ soft measures for the promotion of sustainable transportation take place, which looks even worse as car companies invest a lot of money (more than 1.5 billion € in Germany alone as per 2005, (Wiebeck, 2006)) into advertisements and the promotion of motorized individual transportation. For example, the German Federal Government did not support ride-matching platforms in Germany.

An important area for the application of soft measures is the transport choice, especially the use of non-motorized transport modes.

5.1 Promotion of Non-motorized Transport

In 2002, the “national cycling plan“ was initiated by the Federal Government, a ten year plan for the promotion of bicycling in Germany. Goals are the initiation of awareness campaigns and the coaching of local communities with respect to the promotion of bicycling (Fahrrad-Forum, 2009). Additionally, the research about bicycling and its promotion is expanded (Difu, 2010). In the framework of this plan, the promotion for cycling infrastructure has been expanded to 100 million €/year and the following measures have been executed:

- **“Kopf an – Motor aus“** (which can be translated as “Switch your head on – and your engine off“): In the years 2009 and 2010, this classical image campaign for non-motorized mobility was started in nine German cities. With posters, brochures and direct communication, special mobility groups were encouraged to use the bike or walk instead of going by car (Wuppertal Institut, 2010). The campaign, which was financed by the German Federal Government, cost around 4 million € (approximately 0.3% of the marketing investments of the car industry).
- **“Innovative öffentliche Fahrradverleihsysteme“** (innovative public bicycle rent systems): The research about and implementation of systems for bicycle renting is promoted with 10 million € until 2012. Additional funds of 2.7 million € exist for “pedelecs“ (bicycles with an additional electric engine). In the last years, many projects and bike renting systems have already been implemented (Fairkehr, 2010). It is hoped that the modal share of biking can be improved with flexible and affordable rental systems.

- **"Fahrradforum"** (bike forum): Every three years, trade fairs for the promotion of and consulting about bicycling and the right bike take place. The consulting is free and on their homepage, additional information about the technical and practical side of bicycling can be found: www.fahrrad-forum.info.
- **"Best for bike"** is an annual award that is sponsored by the German Transportation Ministry since 2004. In various categories, persons and communities that successfully promoted bicycling are awarded. Information is available from www.best-for-bike.de.
- **"Radlust"** is a campaign initiated by 25 students at the University of Trier who, until 2010, travelled through Germany and with innovative advertisement and marketing wanted to stimulate urban bicycling. The project was promoted by the Germany Environmental Ministry. Further reading: (University of Trier, 2009)
- **"Stadtradeln"** (Urban cycling): The contest "Stadtradeln" was initiated by the city of Nuremberg. In an annual contest, local communities, especially local decision makers, initiate bicycling contests. Awards for the most cycling individual person or community can be won. The contest is promoted by the German Transportation Ministry: www.stadtradeln.de.
- **"FahrRad!"** (Bike!): This is a contest for cycling for pupils from 12 to 18 years. Each year, school classes can participate in a "virtual bike tour" that continues according to the amount of real bicycling kilometers they perform. This project takes place throughout Germany and is promoted as part of the national cycling plan. More Information: www.klima-tour.de, (Difu, 2008).

Other important transport choice campaigns deal with public transport.

5.2 Promotion of Public Transport

Only small "soft" measures have been implemented for the promotion of a modal shift to public transport:

- **"Nachhaltig unterwegs mit Bus und Bahn"** (travelling sustainably with bus and train): With this image campaign for public transportation, promoted by the Federal Environment Office, especially young people were encouraged to use public transportation. The use of new tools based on new media was tested in a pilot project in the area near Frankfurt, called "youthmove". Part of the project was the implementation of a "wikipedia for public transport", called "mobiwiki" (www.mobiwiki.de). More information: UBA (2010a), Naturfreundejugend Deutschlands (2007).
- **Measures by public transport providers:** Public transport providers like the German Railway (DB) also have image campaigns and marketing measures. As especially DB is massively subsidized by the German Federal Government, those measures can be seen as Federal soft measures for sustainable transportation. Examples are "destiny nature", the integration of public transport and electric mobility or "eco rail innovation" for emission free railway transport: http://www.deutschebahn.com/site/bahn/de/nachhaltigkeit.
- **"Das Patenticket"** (promoting public transport use for the elderly): In this project, funded by the German Transportation Ministry, the use of public transportation for

people older than 60 was promoted. The concept established "sponsorships" between established PT users and older people whose tickets were sponsored. By doing this, it was hoped that existing burdens for the use of public transportation would be reduced. In a further project, Patenticket 2.0, the scope was expanded to rural areas. (TU Dortmund, 2008), (TU Dortmund, 2011).

Urban planning and mobility management have influence on both, transport volume, and modal choice and can be important components of a sustainable transport strategy.

5.3 Urban Planning and Mobility Management

Many model projects for urban planning and its influence on mobility have been implemented and evaluated; still, no countrywide adaption took place:

- **"Modellvorhaben Fußgänger- und fahrradfreundliche Stadt"** (Pedestrian and bicycle-friendly cities): In a project implemented in three small to medium sized German cities, the transformation of cities from a car-friendly approach to a prioritization of non-motorized transport modes was researched by the German Environmental Agency UBA. While being implemented as mainly research oriented, concrete measures have been executed. The focus here was on measures that could be implemented without large financial resource input. The goal of the project was to shift traffic from the car to non-motorized transport modes without favoring one of the modes walking and cycling. More Information: UBA (2006).
- **RAVE-"Nachhaltige Raum- und Verkehrsplanung":** In this project for the research about sustainable spatial and traffic planning, concrete planning tools for traffic avoidance and modal shift were investigated in two model cities. Additionally, the legal framework for sustainable urban planning was investigated and a database of good practice examples for sustainable urban planning was created ((TU Dortmund, 2004), http://www.nachhaltiger-verkehr.de).
- **"Stadtleben"** (city life): In this project, socio-demographic influence factors of sustainable urban planning were investigated. Different life and mobility styles and their development were pointed out. Sustainable urban planning has to take the social development of the inhabitant in a city into consideration. Hence, planning strategies for sustainable mobility in urban development were developed in harmony with social aspects: (TU Dortmund, 2005).
- **"Wohnstandortinfo"** (information on residential location): Funded by the Federal Government as part of funding for the reduction of land use, this campaign, executed in the city Schwerin, informed new citizens of the city about possible residential locations and their accessibility to public transit. With this information, it was hoped that urban sprawl could be reduced and sustainable residential locations could lead to a reduction in traffic demand: (TU Berlin, 2010).
- **"Klima-Kampagnen-Baukasten"** (climate campaign toolbox): With this internet toolbox, project ideas, descriptions, and evaluations can be easily published. As many campaigns lack professional marketing, this toolbox, which is funded by the Federal Government and can be used for free, can help make experiences of mobility campaigns more public (www.klima-kampagnen-baukasten.de). This toolbox is based on the experiences of the project "life events" which investigated the influence of certain

life events on sustainable behavior (www.lifeevents.de).

- **NAPOLI:** In this project, which dealt with the implementation and acceptance of sustainable mobility policies, the evaluation of good practice examples for sustainable mobility and urban planning was the focus. By choosing several measures in two model regions and evaluating them, a guideline for sustainable urban transport planning was created for local communities. The project was funded by the German Transportation Ministry (TU Dortmund, 2005).
- **"Effizient Mobil"***:* The program "Effizient Mobil" or "efficiently mobile" put a focus on urban mobility management in order to make transportation more efficient. In 15 regions, cooperation networks for mobility management were created. In 85 companies, consulting for mobility management, the use of public transportation and ride matching were offered. Consulting for transport managers was offered in the 15 regions. The Federal Government with 2 Million € promoted the project. (http://www.effizient-mobil.de/, (BMU, 2010)).
- **"Deutschland-Takt"** (German synchronized timetable): The introduction of an integrated synchronized timetable for railway traffic is the goal of this project, which was introduced by the organization of regional railway service providers officially started in September 2011. As they are massively funded by the German Federal Government, this initiative is included in this list. A synchronized timetable throughout Germany could reduce the waiting times for passengers and is expected to make railway traffic significantly more attractive (http://www.deutschland-takt.de/deutschlandtakt/).
- **Telematik systems:** The use of information and communication technology for traffic control in Germany is a Federal responsibility only for the motorways. According to Auto, Motor und Sport (2009), around 40 million € are spent annually for such systems; however, no broad initiative for their implementation was announced.

A soft measure dealing with the reduction of car and bus emissions is the promotion of efficient and fuel-saving driving behavior.

5.4 Promotion of Efficient Driving Behavior

Although it is an effective soft measure, efficient driving behavior has not yet been promoted extensively:

- **Eco-driving trainings:** A fuel saving driving behavior can reduce fuel consumption and, therefore, car emissions by up to 25% (UBA, 2009). Nevertheless, the German Federal Government does not promote this cost-efficient measure to emission reduction for all car drivers, but only for driving teachers with annually 500,000 Euro (Autosieger, 2007).

While new mobility concepts can be used to promote alternative ideas about mobility, working concepts can lower the transport volume (e.g. teleworking).

5.5 New Mobility and Working Concepts

Only few initiatives for alternative mobility and working concepts have been started or promoted by the German Federal government:

- **Alternative working concepts:** Except for a new initiative for family-friendly working times (Federal Government of Germany, 2010a), no attempt of the German Federal Government for the promotion of innovative working concepts could be found
- **Car Sharing:** The establishment of car-sharing systems is not actively promoted by the German Federal Government (in contrast to Italy, for example: Loose, 2009), but some funded research projects had the establishment of car sharing as subject (Oeko Institute, 2001).

5.6 Other Public Awareness Programs

Other public awareness programs include the following initiatives:

- **"Steigerung der Akzeptanz beim Stromsparen und nachhaltiger Mobilität"** (Improving acceptance for saving electricity and sustainable mobility): With the help of empirical research in 15 different user groups, the acceptance and evaluation of "smart driving meters" for a more fuel saving driving behavior in personal cars is investigated. Based on this, recommendations for the effectiveness of feedback systems for behavioral changes will be produced (BMU, 2010a).
- **Guidebooks**, for instance for fuel saving driving behavior (UBA, 2009).
- **"Kurz-nah-weg"** (Short – close – gone): Under this slogan, the German National Tourism Board (DZT) has started large advertisement campaigns to promote holidays within Germany. The project has been promoted by the Federal Government and is listed here, as inner-German holidays (especially if done with public transportation) cause much less emissions than long-distance holidays. http://www.kurz-nah-weg.de
- **Labelling:** Providing information about fuel consumption and emission is a measure that can induce more sustainable car purchasing behavior. As car labeling is mandatory in the EU, a description of the measure is done in chapter 3.11.
- **„Für mich, Für dich, furs Klima"** (For you. For me. For the climate): With this slogan, the German Environmental Ministry funded a campaign with the goal of promoting environmentally friendly behavior, especially in mobility. With internet advertisements, brochures, consulting about mobility behavior and a tour through many cities, sustainable mobility patterns were promoted. (Fairkehr, 2011)

Given the overview of federal efforts for sustainable mobility in the areas of regulatory, fiscal and „soft" measures, the effectiveness of combining these measures is assessed, as well.

6. Political Packages

When measures for sustainable mobility are implemented, it is sensible to combine them in political packages to use possible synergy effects. An increase of fuel taxation, for example, could be accompanied by an image campaign for sustainable transport modes. On the other hand, a higher fuel tax has lower effects if it is accompanied by the construction of new roads by which new traffic is generated (cf. chapter 2.2).

To ensure a maximum efficiency of measures for the promotion of environmentally friendly transport behavior, hard measures should be combined with soft measures (Otto, 2010). Hence, a good political package for sustainable transport includes both, hard measures such as regulation and fiscal measures, and soft measures that raise awareness and offer transport alternatives.

In general, the following guidelines for political packaging of sustainable mobility are important:

- Combine measures from different A, S, I categories (if the focus is on one category, for instance vehicle improvements, further improvements in this category become more and more expensive and less efficient with time).
- Combine hard and soft or "push" and "pull" measures as it is important to provide alternatives if a certain transport behavior is sanctioned (Vlek, 2004).
- As sustainable mobility policies are subject to very high cost differences, it is a matter of economic reason to start with the cheapest policies in each ASI category.

UBA (2003) suggests the following order of political packages for sustainable mobility: At first, "avoid" measures reduce the total traffic amount, which makes the implementation of "shift" measures easier and "improve" measures cheaper. Secondly, measures for the shift to environmentally friendly transport modes are implemented. Lastly, a focus on vehicle improvements should be set (the reason is that one hopes that many people have switched to environmentally sound transport mode that makes vehicle improvements cheaper and better easier to plan). As "order of importance", the following measures (cf. UBA, 2003) are suggested to the Federal Government of Germany by the Federal Environmental Agency (measures in brackets out of scope for this thesis):

1. *Basic package:* Fuel taxation increase
2. Promotion of long distance railway traffic, promotion of local public transport, promotion of non-motorized transport modes, (implementation of efficient railway freight traffic systems)
3. Cost-efficient vehicle improvements such as fuel saving oil and tires
4. More stringent speed limits
5. Promotion of eco-driving
6. CO_2-based car taxation
7. Vehicle improvements for buses, (aviation tax)

Another suggestion for a sensible package structure for sustainable mobility is the following (cf. Bongardt, Breithaupt, & Creutzig, 2011):

1. Basic package:
    - Urban planning guidelines
    - Improve energy efficient mode infrastructure
    - Removal of fuel subsidies, additional fuel taxation
2. Advanced package:
    - Licensing car ownership
    - Financial incentives for the use of energy efficient modes
    - Annual vehicle registration tax
    - Vehicle fuel economy standards
3. Complementary package:
    - Cap system for vehicle manufacturers
    - Promote research and pilot projects (of new technologies and concepts such as the electrical car or car-sharing)
    - National cycling plan
    - Vehicle labeling
    - Mandatory eco-driving trainings

Given this description of the measures implemented by the German Federal Government and a small theoretical description of policy packages, now the effectiveness of the German Federal Government in making transport more sustainable is analyzed.

7. Evaluation

In this chapter, the effectiveness of the German government with regard to sustainable mobility is evaluated in five different categories: Regulatory measures, fiscal measures, "soft" measures, political packaging and an overall, indicator based evaluation with respect to the goals of the German Federal Government described in chapter 3.
Apart from this last step, the evaluation will mainly be qualitative, but will include quantitative effectiveness ratings, where possible. At the end of each sub-chapter in the categories, a mark for the effectiveness of the German Federal Government in implementing this measure (compared to its potential) will be given. Here, "0" means a very poor implementation (or no implementation at all) and "10" a well-balanced, effective and sufficiently evaluated implementation. Based on the order of chapters, regulatory measures are analyzed at the beginning.

7.1 Regulatory Measures

In the following subchapters, an evaluation of the effectiveness of German law in promoting sustainable transportation in the measure categories given in chapter 4 is provided.

7.1.1 Urban Planning

- ⇨ *(associated law books: Federal building code (BauGB), esp. §1.5 and §1.9, Territorial Planning Code (ROG), esp. § 2.2)*

In the last 25 years, a constant sealing of soils for residential and traffic purposes and an increasing settlement density (inhabitants per settlement area) can be observed: In the year 2000, 131 ha per day have been "occupied" by the inhabitants of Germany, a value that has decreased in the years after. This decrease, however, was due to the weak development of the German construction sector (Government of North Rhine-Westphalia, 2010). In recent years (even after 2004, when the environmental inspection for construction activities became obligatory) no significant improvement is visible (UBA, 2010d), although the population in Germany is not growing but even slowly decreasing (German Statistical Office, 2011).
In total, 12.9% of the area of Germany is now occupied for residential and transportation purposes, thereof 2.1% for transportation purposes (Umweltschulen.de, 2011). The problem is especially pressing in eastern Germany, where settlement density is (also due to lower housing prices) very low (German Institute for Urban Research / BBR, 2006) and more and more area is consumed. Since valuable areas for wildlife, forests and water protection are destroyed, this development is in contrast to §1.5 BauGB where it says about urban development plans:

"They shall contribute to the preservation of a humane environment and to the protection and development of the natural basis of life, also in responsibility for climate protection (...)"

The average residential room per capita in Germany grew from 16 m² in 1950 to 40 m², which is also due to a changing social structure and the decline of the German "Großfamilie", in which different generations lived in one house (Government of North Rhine-Westphalia,

2010). UBA (2010d) concludes that the current consumption of urban and residential area (with the described impacts on transportation) is not tolerable and that no additional areas should be sealed if the population is decreasing.

In 1985, a goal of 12 to 13 ha daily area consumption was proposed by 2010 (BUND Dortmund, 2003); the current goal is 30 ha/day by 2020 (Government of North Rhine-Westphalia, 2010)). The goal of the federal government to increase the settlement density substantially and lower area use has failed despite a slow land consumption decrease in the last years: Although Germany has a very high settlement density and, therefore, potentially lower area consumption compared to other countries such as the USA, this value is decreasing, which causes additional traffic. The overall traffic volume has rapidly increased since 1991 (as shown in chapter 7.5) and continued increasing also after 2004. Consequently, the goal of ROG, §2.2 (*"Spatial structures have to be designed such that traffic is reduced and additional traffic is avoided")* has not been met.

The conclusion has to be made that the federal strategy of avoiding traffic by appropriate urban planning has failed, although the area consumption has decreased in recent years. The rating is **3/10.** Now, an assessment of the promotion of regional economic cycles will be performed.

7.1.2 Promotion of Regional Economic Cycles

⇨ *(associated law books: Treaty on the Functioning of the European Union, Art. 174, Charta of the German Federal Republic, Art. 91a , Regulation About the Common Task 'Promotion of Regional Economic Cycles' (GRWG))*

UBA (2003b, p.142) states that regional economic promotion, as it currently exists in Germany acts *against* the promotion of regional economic cycles as it focuses solely on the export of regional goods rather than on the promotion of local cycles. Forum CSR International (2008), in contrast, argues that only export can help local regions grow sustainably. UBA (2003b) criticizes that a direct promotion of regional economic cycles is not possible in the current GRWG, but that only indirect financing without the assessment of effects is possible. Additionally, the traffic volume impact of the current law is unclear. While in some regions, traffic volume has indeed been decreasing, in other regions, traffic volume has increased (ibid.). This shows that the task written down in the *Treaty on the Functioning of the European Union*, Art. 174 ("*the Union shall aim at reducing disparities between the levels of development of the various regions and the backwardness of the least favored regions")* is very complicated. OECD (2007) sees a lot of improvement potential in the development of rural areas in Germany as well and advises Germany to adjust and expand the GRWG to improve local economic cycles. It can be concluded that room for improvement exists and that the German Regulation *"About the Common Task 'Promotion of Regional Economic Cycles'"* has only partly been successful in its task. The rating here is **5/10**.

Now an analysis of introduced environmental zones in inner cities with respect to the decrease of PM emissions and the lowering of total transportation demand will be performed.

7.1.3 Environmental Zones / Driving Bans for Environmentally Unfriendly Cars

⇨ *(associated law books: Federal Emission Control Act (BimSchG), especially §40, "Regulation for the Labeling of Low-polluting Vehicles" (35.BImschG))*

UBA (2009h) shows little to no decrease in particulate matter emissions in recent years. It also becomes obvious that pollution near roads is higher than at points away from road traffic, although the difference is not very high (but may be sufficient to provoke an exceeding of the 50 µg/m³ threshold). In the year 2010, many cities exceeded the maximum of 35 days of exceeding the PM threshold: (Frankfurter Rundschau, 20.10.2010), which means that the requirements of 22nd BImSchG are not met in this year. Hence, Germany is accused by the EU of not holding the promised reductions and has to explain how it is going to combat these violations of European law (ibd.)

Referring to Umweltruf (2010), the individual implementation of environmental zones based on §40, BImSchG in different cities (especially in areas like the Ruhr area where many cities are located next to each other) is not effective. They suggest the establishment of a federal regulation or at least a larger environmental zone. This is also partially admitted by the government of the state North Rhine-Westphalia (Government of North Rhine-Westphalia, 2010a). Referring to FR (20.10.2010), the financial promotion of particle filters was stopped at the end of 2010. Additionally, construction machines are responsible for one third of the emissions, but German law does not regulate their PM emissions. Therefore, one can conclude that despite slowly decreasing emissions (cf. chapter 7.5), there is again a lot of space for improvement in Germany´s regulation policy to finally combat PM emissions.

Concerning the impact of the environmental zones on total traffic demand and modal split, only one evaluation could be found: The city of Berlin reported a decrease of car traffic of 6.3% outside the environmental zone and 3.9% inside the zone (City of Berlin, 2009). This is a positive result, as no traffic seems to be shifted to the area outside the environmental zone as compensation for reduced traffic within the zone.

In summary, environmental zones / driving bans are a sensible measure to lower (or shift) PM emissions and promote the purchase of less polluting cars. The method of regulation in Germany, however, is not optimal, and the results are not as good as anticipated. Hence, additional measures are necessary to combat PM emissions successfully. The rating here is **5/10**.

Driving bans are not sensible without a promotion of alternative transport options, therefore, now for the assessment of public transport promotion.

7.1.4 Promotion of Public Transportation

⇨ *(associated law books: "Devolution Act for Public Passenger Transport" (RegG), especially §1 and §6, "Act for Financial Support of the Federal Government for the Improvement of the Transportation Situation in Municipalities" (GVFG))*

Although each year many billions of euros are spent on the promotion of public transportation by the federal government for the Bundesländer and the counties, according to §4.1, GVFG and §6, RegG, the most important indicator, the modal split, has not changed significantly.

The modal split of public transport modes stagnates at the low level of around 14% (cf. chapter 7.5) and even the optimistic projection of UBA (2010) sees only a potential for an increase of up to 18 to 20%. Two thirds of Germans hardly ever or never use public transportation presently (UBA, 2007c). This shows that the *"Devolution Act for Public Passenger Transport" (*RegG*)* has up to now failed to promote public transport in Germany.

Some reasons may be that fiscal promotion is given to the local transport service providers without any conditions concerning effectiveness, passenger numbers or environmental friendliness (compare chapter 7.2 about the fiscal measures). Moreover, although EU regulation 1370/2007 regulates an open advertising of transport services and a federal promotion only for providers working based on efficiency and economic standards (which makes governmental transport providers fear for their existence: (TAZ, 23.6.2008)), corrupt structures between governments and the (half-)governmental transport providers such as the German Railway (DB) have been uncovered (SPIEGEL, 13.12.2010). In addition, a cost covering of around 50% (TU Dresden, 2004) seems improvable. It may be that the inefficiency of public transport providers has a big influence on the low popularity of public transportation in Germany.

BMU (2000) criticizes the still missing competition in the public transport sector, which prevents efficiency improvement and better service. The president of the railway transport service providers accuses the German Railway (DB) and the federal government of systematically preventing competition without a legal basis (Frankfurter Rundschau, 23.5.2011). Additionally, emission standards for public transport do not exist at all for electrically driven transport modes in the *Federal Emission Control Act* (cf. chapter 3.9).

In a study conducted by the German Automobile Club ADAC, regardless, public transportation in urban areas is rated as very well, but too expensive (FOCUS, 18.2.2010). Similar results are provided by a travel agency (ab-in-den-urlaub.de, 2010), which showed that German urban transportation is very expensive compared to international standards and that the amount of service provided does not compensate for extreme price increases in recent years. Admittedly, the association of German transport providers VDV presents a study (TNS Infratest, 2009) that supposedly shows that customer satisfaction has improved, but a grade of 2.78 (on a scale of 1-6) is not optimal, especially since cost-effectiveness is graded with 3.61 and punctuality with 2.9.

German federal law (in as far as it has influence on local transportation), especially RegG and GVFG, consequently, has more or less failed to provide affordable, convenient and effective public transportation, although the prerequisites in Germany are very good compared to international standards: A dense railway network and a long tradition of public transportation exist here.

The lack of competition and quality assessment of the financial promotion leads to a failure in promoting public transport in Germany (which still has a high standard compared to other countries). This is also the fault of the federal government, which has a lot of room for improvement. As a result, the score is only **4/10**. Now we proceed to an evaluation of fuel standard regulation in Germany.

7.1.5 Fuel Improvements

⇨ *(associated law books:10th and 20th change of the Federal Emission Control Act (BimschG), Regulation for Sustainable Biofuels (Biokraft-NachV))*

Here, only fuel standards for the reduction of air pollution will be assessed. biofuels are evaluated in the chapter for fiscal measures.

The introduction of sulfur-free fuel as well as other fuel standards has undoubtedly contributed greatly to the massive decline of air pollutants such as SO2, NO_x and VOC´s (see chapter 7.5). Since fuel costs have not risen dramatically due to these new standards, regulation of fuel standards (which happened independent of EU regulation and a lot earlier) was, therefore, an effective measure to improve air quality in Germany. It can be concluded the German federal policy for fuel standards, as introduced in 10.BImSchV, was successful in reducing air pollutants. The rating here is **10/10.** Related to this measure, in the next chapter, the electricity mix of the German Railway (DB) is investigated.

7.1.6 Electricity Mix of the German Railway (DB)

Although the emissions of CO_2 per pkm are low compared to the car (42 g/pkm for long distances, 72.7 g/pkm for short distances, DB, 2011) and decreasing, the electricity mix is quite dirty with almost 50% coal and 20% renewable energy, of which 8.5% are just green certificates (German Parliament, 2011). Additionally, new investments into nuclear energy and coal are planned (Greenpeace, 2010). Hence, the effectiveness of the German government to regulate the electricity emissions of the German Railway (DB) is rated only with **5/ 10**.

In the next chapter, emission standards, the next higher level of emission regulation after fuel standards, will be assessed.

7.1.7 Emission Thresholds

⇨ *(associated law books:§48 StVZo (road vehicles), FZV, §11a (road vehicles), 28th change of the Federal Emission Control Act (28.BImschG) (diesel powered locomotives))*

The introduction of emission standards for road vehicles has successfully reduced ozone precursor emissions such as NO_x and VOC´s as shown in chapter 8.1.2. Nevertheless, German federal law only had a small influence on this development – it remains unclear how much the intermediate norms D3 and D4, which were implemented in BimSchG, accelerated the shift to more efficient vehicles. Consequently, an assessment of German law in promoting vehicle efficiency standards for road vehicles remains difficult. Still, it can be stated that Germany made no effort to promote stricter emission standards, especially since the new Euro 5 and Euro 6 norms fall behind international standards, and no longer has the leadership in worldwide road vehicle emission standards (Transport & Environment, 2006). Since Germany is home to leading car manufacturers and is a large market for automobiles, the promotion of stringent standards (e.g. D5 & D6) would have been a promising way to give incentives for further emission reductions.

In 2010, 69.7% of all newly registered cars complied with the EURO 5 standard (KBA, 2011b), which lead to a share of EURO 5 cars of 7.1% of the total fleet (KBA, 2011a). In May 2011, 96.7% of all newly registered cars complied with the EURO 5 standard (KBA, 2011c); in October 2011 even 98.6% (KBA, 2011d). EURO 6 vehicles, however, stay the exception with a share of only 0.2% of newly registered vehicles (ibid.). These values show that the integration of new emission standards into the German vehicle fleet is happening relatively efficiently, which should further reduce NO_x, VOC and SO2 emissions and can be seen as a success of German policy.

German law surely has failed in implementing a CO_2 emission standard for passenger cars, as shown in chapter 7 – especially since UBA (2003a) estimated that a 120 g/km average emission could be achieved by 2010 with appropriate measures. A possible introduction of CO_2 or fuel consumption thresholds could have been implemented in FZV, §11, for example, but no effort was made by the federal government – instead they relied on the promises of the car industry. Again, we see that the federal government is eager to please the car industry for economic and political reasons and does not implement additional requirements for them.

Railway emission standards are divided into diesel locomotives and electrical locomotives: EU regulation provides regulation for diesel locomotives (which were implemented in 28.BImSchV), while electrical locomotives remained untouched by regulation, as almost no direct emissions are emitted. Still, there are - as (UBA, 2010) shows – certain improvement possibilities for energy consumption such as eco-driving trainings and technical improvements, which have not been considered by lawmakers yet.

German law, although mainly forced by EU directives, successfully regulated air pollutant emissions in all transport modes and proved very effective in this. Concerning greenhouse gases, however, no regulatory attempt, such as the implementation of CO_2 thresholds, has been made so far – the policy of the federal government promotes the use of fiscal and "soft" measures for GHG emission reduction. Legal measures, nevertheless, could significantly contribute to GHG emission reduction; the German policy is not understandable. Therefore, the rating is **6/10**.

Similar conclusions can be drawn for the combatting of air conditioning emissions, where the federal government also reacted far too late.

7.1.8 Air Conditioning Emissions

⇨ *(associated law books: "Regulation for the Protection of Climate from the Entering of Fluorinated Greenhouse Gases" (ChemKlimaschutzV))*

The new regulation 2006/40/EC, which prohibits the old refrigerant R134a as of 2017 for all new cars and 2011 for all newly developed cars was implemented into German law in ChemKlimaschutzV (Frankfurter Rundschau, 3.11.2010). It is, however, bypassed by the German car industry, which has registered many new car types that use R134a until 2017 (ibid.). Eventually, emissions from leaking air conditioning systems will be successfully eliminated – but what role does German law play here? The UBA made the public aware of the

climate impact of R134a as early as 2001 (Schwarz, 2001). Already since the 1990´s, a much more (and at 50€ per car only slightly more expensive, but energy efficient) environmentally friendly refrigerant for air conditioning has been proposed – CO_2, which is also known as R744. We see that more climate friendly and not too expensive alternatives for R134a exist. Although the climate impact of R134a has been known for almost 10 years and alternative refrigerants are shown to be more effective and less polluting, German law makers have not taken steps towards a reduction of R134a emissions. Moreover, although it is known that the alternative refrigerant proposed by the car industry (R1234yf) is highly flammable and in the worst case even explosive (UBA, 2010e & Federal Institute for Materials Research and Testing, 2009), no attempts have been made by the federal government to promote the much more efficient R744 (UBA, 2009g & UBA, 2010f). It can be concluded that although one can expect that the problem of air conditioning caused GHG emissions will be solved by EU law in the coming years, German law (the implementation of directive 2006/40/EC into ChemKlimaschutzV) has not made a serious attempt to solve the problem before (maybe due to pressure from automobile manufacturers). Hence, the rating is only **3/10.**

Similar can be said for the efficient labeling of car CO_2 emissions, although improvements are visible here.

7.1.9 Car Labeling

⇨ *(associated law books:"Passenger Car Consumption Labeling Regulation" (Pkw-EnVKV))*

In compliance with EU directive 1999/94/EC (as successor of directive 92/75/EWG about efficiency labeling), customers must be informed about fuel consumption and CO_2 emissions when buying a new vehicle. This directive was implemented into German law in the "*Passenger Car Consumption Labeling Regulation*" (Pkw-EnVKV) in November 2004, which obligates car dealers to inform customers about the emission and fuel consumption of cars.

Environmental associations such as the German Environmental Aid (DUH, 2009) criticize that the sheet required by Pkw-EnVKV, which presents emission and consumption data at car dealers and online, is too small and not intuitive enough. They propose the introduction of a "traffic light system" that would intuitively informs customers about the environmental impact of their cars (from green to red). Environmental agencies found that many dealers do not implement the regulations or provide false or misleading information. According to LME Rhineland-Palatine (2008), especially independent dealers do not comply with the regulations of Pkw-EnVKV more than 70% of the time. Environmental organizations accuse the federal government of conceding to the car industry that successfully stops an efficient information system fearing a negative impact especially on the sale of big cars. This fits into the pattern we have already seen before.

As shown, the current manner of labeling passenger car emissions is insufficient (UBA, 2010), thus an easily understandable and suggestive labeling such as the "traffic light system" should be introduced. This critique has been successful. Referring to (Autohaus Online,

12.8.2010) a revision of the Pkw-EnVKV was introduced for 2011, in which these improvements are implemented. Here, we see that criticizing an insufficient law can lead to a revision and improvement. This new regulation, which was introduced in December 2011, regardless, favors heavy cars according to environmental organizations, as the label is based on the relationship between weight and CO_2 emissions and can lead to an "A" label for any car, no matter how much it consumes (Service Insiders, 2011). German law corrected its failure to implement directive 1999/94/EC, but in a way, that does not really favor the purchase of low-consuming cars. Due to this and the low implementation speed, the rating is **4/10**. No analysis was conducting in the case of particulate filters for diesel vehicles.

7.1.10 Particulate Filters in Diesel Vehicles

As described in chapter 4, the use of particulate filters in diesel vehicles was not regulated by the German Federal Government; however, most of the new diesel cars have this technology implemented. Hence, no rating of the effectiveness of German Federal law is performed here.

7.1.11 Speed Limits on Highways

The failure of German politicians to implement a speed limit on German motorways should be taken very seriously, not only because of the direct impacts of a missing speed limit (described in chapter 4), but also because of psychological impact. The lack of a speed limit provides the excuse for excessive speeding, an increased use of private cars, the trend toward more powerful (and more fuel consuming) cars and in general a perceived "right to speed". Germany experiences illegal car races and a "speeding tourism" (FAZ, 2007) and is (mainly because of its missing speed limit) an Eldorado for the use of private cars. Although these impacts are known and low-level discussion about a speed limit is taking place, and although many governmental organizations such as the German Environmental Agency proclaim a speed limit for decades, no Government has had the courage to implement a speed limit yet. Consequently, the rating can only be **0/10.** For the promotion of long distance buses, the analysis looks differently.

7.1.12 Promotion of Long Distance Buses

The monopoly for the railways as the only allowed public transport providers for distances longer than 50 km was not sensible as was described in chapter 4. Therefore, the decision of the German Federal Government to open the market to long-distance buses is a good decision that is expected to improve public transport quality and to provide transport alternatives. Nevertheless, it has to be questioned, why this regulation took such a long time. Rating: **8/10.**

7.1.13 Conclusion

Fuel regulations and emission thresholds for air pollutants are examples of successful regulations. Still, although many useful regulations exist (for instance concerning urban planning

and traffic avoidance), their implementation is often very vague. A big failure of course is the lack of a speed limit for motorways in Germany. The regulatory efforts for sustainable transportation of the federal government are rated with **6/10.**
The next chapter will provide an analysis of federal fiscal efforts for sustainable transport.

7.2 Fiscal Measures

The evaluation of the effectiveness of fiscal measures is difficult: Although the financial revenue or cost of such measures can easily be measured, an impact assessment is difficult because of the close interaction with economic and political issues. Additionally, expert assessments differ very much from each other, depending on the personal opinion of the expert. However, no social or economic impacts will be considered here, as this thesis only deals with the environmental impact of measures.
We start with the analysis of the fuel taxation policy.

7.2.1 Fuel Taxation

A publication by the German Environmental Agency (UBA, 2005b) quantifies the effect of a 1% fuel price increase with a 0.15% -0.3% decrease in vehicle mileage and a 0.3%-0.6% decrease in fuel consumption. It shows that although mileage in Germany was still on the rise after 1999, and refueling abroad indeed increased, the effect is smaller than expected and fuel consumption significantly decreased. Zahrndt & Seiche (2004) also ascribe the shrinking fuel demand in Germany to the fuel tax. Research Center Juelich (2008, p.143ff.) conducts a literature study on the effects of the raises of the fuel taxation from 1999 on and comes to the conclusion that CO_2 emissions in the transport sector have been reduced by around 2.3% compared to the reference scenario. The publication sees positive effects on public transport as well. Storchmann (2001) quantifies this effect in a simulation with a projected modal split increase of 1.2% for public transport). The effect, however, is limited to the five years after the raise of the fuel tax, after 2010, CO_2 reduction is projected to remain at a stable level.

The effect on the total amount of traffic is rather low: According to DIW (2010), around a 1% reduction was achieved (with higher reduction in higher income classes).

It was often argued that the rising taxes do not create less traffic but lead to growing “fuel tourism“, as described by Thoene (2008). The overall effect of fuel tourism, nevertheless, remains small. It is unclear, how the further development of the fuel tax (which has to be seen in connection with the development of car taxation and possible road taxation) will turn out to be, as the current government is not willing to consider further taxation steps.

Still, referring to UBA (2010), another 12.3% emission reduction is possible with a further growth of fuel taxation. A DIW study speaks against this: Although undoubtedly effects of the increased fuel taxation have been visible in the past, they are not sustainable, as higher income leads to a faster expansion of road transport than the lowering effect of higher fuel prices (Welt, 2010).

A conclusion that can be drawn is that fuel taxation alone cannot make transportation sustainable: Although an effect is evident, it is comparatively small and will be eliminated if incomes grow. Still, as fuel taxation creates additional revenues, it should not be neglected, either. The German Federal Government effectively used the "double dividend" created by the increased fuel tax to keep wage taxes low and reduce fuel consumption by road transportation. Nevertheless, the Schröder government abandoned further planned steps of the tax and the new Merkel government since 2005 was unwilling to consider a further increase, as well. Additionally, the lower tax rates for diesel fuels do not make sense, as the CO_2 emissions of diesel fuels are only marginally smaller, but the emission of air pollutants such as particulate matter is increased (Die Zeit, 2011). The overall rating of the German Federal Government concerning the fuel taxation, hence, is **7/10**.
Now we come to an analysis of car taxation.

7.2.2 Car Taxation

Car taxation in a CO_2 -based version is sensible to promote the purchase of an emission-reduced car although the effectiveness of the current implementation cannot yet be assessed in detail.

Based on a simulation, a more stringent and completely CO_2 -based (unlike the current concept, which is only partly CO_2 -based) could lead to a reduction of 4.2 Million t CO_2 by 2030 (UBA, 2010, GWS, 2004). The German Environmental Agency criticizes that the current tax is not stringent enough, as low emitters are not exempted from the tax and as it is not based on CO_2 alone, but also on the engine power. Additionally, the exemption of agricultural machines is criticized (Greepeace, 2008) (an evaluation of the tax exemptions for electric mobility will be done in the chapter "subsidies"). A grave point of criticism is that many older vehicles are still taxed according to the old system and that no incentives for the replacement of old, highly emitting vehicles are given.

In conclusion, it can be stated that the CO_2 -based taxation is a step into the right direction, but that various exemptions and the fact that it has not been implemented consistently, lower the rating. Although the taxation is based on both, CO_2 emission and engine power, new cars in Germany continue to become stronger: From 95 PS in 1995 to 134 PS in 2011 (which is in large part due to a higher share of SUV´s (Ruhkamp, 2011) , which the taxation in Germany failed to make less attractive). Consequently, the rating is decreased to **5/10.**
Next to follow is the analysis of the policy concerning road taxation.

7.2.3 Road Taxation

Although a road tax was already implemented for lorries and trucks and "toll-collect", an electrical system for the automatic registration of the performed kilometers, is already in place, a road taxation for private vehicles is not planned. Despite of the advantages such a system offers, the German Federal Government refuses to consider it for political reasons,

such as fear of the public backlash and the lobby of the car industry. Although some less prominent politicians in some parties suggest its implementation, it cannot be expected that a road tax will be implemented. Additionally, the concept is not new and has already been successfully implemented in many of Germans neighboring countries. Hence, the rating for this measure must be **0/10.**
No analysis can yet be made of a possible cap-and-trade system.

7.2.4 Cap-and-trade System

The implementation of a cap-and-trade system is a sensible, but radical approach for the lowering of CO_2 emissions from the transport sector. Although a study was conducted as early as 2005 (UBA, 2005), such a system is still in its earliest research state on Federal and EU level. Therefore, the effectiveness of the German Federal Government cannot yet be evaluated. However, no major efforts by the German Federal Government for the promotion of this idea have been visible up to now.
As next step, subsidies for sustainable mobility are analyzed.

7.2.5 Subsidies

In this chapter, direct or indirect subsidies for the promotion of sustainable mobility are evaluated.

Scrapping Premium 2009

At first, the scrapping premium from 2009 is analyzed. Around 5 billion € were spent for the scrapping of 1,932,929 cars, which were mostly replaced by smaller cars with an average CO_2 emission of "only" 142 g/km (Federal Ministry of Economics, 2010). According to IFEU (2009), around 1 million tons of CO_2 have been saved; the same amount, however, could have been reduced if every car driver would have lowered his annual kilometers by 170 or would have reduced the ballast of his car by 5kg (Ceval, 2010). Referring to Brake (2009), the emission balance of the scrapping premium could be even negative, when lifecycle emissions of the new cars are taken into consideration.

Conclusion: The scrapping premium was a success for the German car industry; the car emissions have not been reduced significantly.

Electric Mobility

The decision of the German Federal Government not to support the purchase of electric vehicles directly has been both criticized and welcomed (Knop, 2010). One billion euros are already spent annually for research and promotion projects and the exemption from vehicle taxes (Doll, Fuest, Greive, & Kaiser, 2011). Until now, regardless, only around 2400 electric cars exist (KBA, 2011a), so the plan of 1 million electric cars by 2020 seems very ambitious. Additionally, electric vehicles may be an option if electricity production is switched to renewable sources, but are currently not much more environmentally friendly than efficient conventional

cars (Friedrich & Petersen, 2009); nevertheless, the car manufacturers may account the emissions of electric cars with 0 g/km, independent of what the real emissions are (ibid.). The half-hearted promotion of a technology, which may be useful in 20 to 30 years with 1 billion € each year, therefore, seems like a waste of money and appears to be another subsidy for the car industry. With 1 billion € per year, many more emission reductions could be achieved more conventionally. Still, it is hoped that these investments pay off in the future.

Public Transport

The promotion of public transportation (PT) is the key concept of the promotion of sustainable transportation and it cannot be doubted that a successful public transport concept has major benefits in respect to air quality, greenhouse gas emissions and space usage. Additionally, positive social effects can be observed in connection with public transportation. In terms of the effectiveness of modal shift measures, however, things look different: Investments in PT infrastructure are very expensive and the avoidance costs of CO_2 are very high as well (Harmsen et al., 2003). An increase in modal split does not mean that emissions are reduced: Many of the users in modal shift campaigns switched from the modes walking and cycling (UBA, 2010). This ineffectiveness of the promotion of public transportation is clearly visible in Germany: Although 15 billion euros are invested in public transportation each year (TU Dresden, 2004) and only 50% of the costs are covered by ticket sales and other revenues, the modal split was not significantly increased. This is mainly because the federal government, states and the municipalities all have different interests and because money is given without assessing the effectiveness of PT measures and without evaluation of the impacts. A massive promotion of PT does not have to be bad, as the example of Switzerland shows: With a consequent promotion of local public transport and the use of seasonal tickets, the train has a three-time higher modal share than in Germany (Richter, 2010).

The promotion of public transportation is an important component of soft measures for sustainable transportation but more focus has to be laid on the effectiveness of these measures: 60% of all investments of the German railway (DB) flow into long-distance transport, although only 10% of all trips conducted are in this distance category (Ascoli, 2006). Hence, clear competences have to be marked between the different actors. One focus should be the promotion of renewable electricity production that would reduce the emissions of (not only) public transportation and on awareness campaigns (if a proper PT infrastructure exists), which are a cost-efficient way of promoting sustainable transport modes instead of expensive new infrastructure projects. Furthermore, local public transport services should be improved.

biofuels

An important key project for sustainable mobility of the German Federal Government is the massive promotion of biofuels. In the EU Germany is in total and relative terms by far the biggest consumer of biofuels with more than 11% (EEA, 2009), even though the European Environmental Agency advised the suspension of the EU target of a 10% share (EEA, 2008).

The reason is that there is not enough space in the EU for the growth of plants for biofuel production (Greenpeace, 2008a) and that biofuels have to be imported from other (mostly tropical) countries, mainly Brazil. In these countries, tropical rain forest is destroyed, causing biofuels from these sources to have clearly negative environmental effects (Umweltinstitut München, 2011).
Nevertheless, growing plants for biofuel production is promoted with 450 €/ha by the EU and with tax reliefs from the German Federal Government (compare chapter 5). As Wuppertal Institute (2007) shows, the import of biofuels causes massive economic, social and environmental problems such as a reduction in food production, deforestation, loss of biodiversity and the endangerment of indigenous populations. It is even unclear if biofuels really emit fewer greenhouse gases, if a life-cycle assessment is taken into consideration. A meta-study by Federal Agricultural Institute Austria (1999) says it does while (EU Tech, 2008) states that the use of biomass for heat and electricity production is much more efficient than its use for fuel production. The EEA sees big accounting errors for emission reductions of biofuels, as the current methodology does not take the former (maybe carbon storing) land use into consideration (EEA, 2011a).
According to Biokraft-NachV, biofuel import into Germany is only allowed, "*if the biofuel shows a significant greenhouse gas reduction"*. In 2009, the necessary sustainability labeling for biofuels was introduced in the Biokraft-NachV:

"The federal government is empowered to prescribe that biofuels are only (...) taken into account if it is verifiable that certain ecological and social standards (...) have been fulfilled at the production of the biomass.

This a step in the right direction (statement of the federal government: "*We prefer sustainably produced oil over cheap imports*" (Federal Government of Germany, 2008)); nevertheless, it remains unclear whether the criteria for this label are stringent enough. Environmental organizations (such as INKOTA, 2010), therefore, criticize the federal government for the introduction of the 10% bioethanol quota from 2011 on, because of a lack of certification criteria, slave work, pesticide use and deforestation promoted by this decision. Wirtschaftswoche (1.9.2007) agrees: Biofuels lower food production and accelerate deforestation and should not be promoted by the government as a consequence. Moreover, promoting biofuels is an example of shifting the responsibility for emissions in the transport sectors of industrialized countries to another sector (agriculture) or even to developing countries (Luhmann & Arnold, 2011).
The German Federal Government, however, abides by its decision to promote biofuels. UBA (2007d) criticizes that 1st generation biofuels with a significantly reduced effectiveness are still promoted by the federal government and proposes a switch to the more suitable 2nd generation. This analysis sees a large potential in biogas fuelled cars and states that research in this field has advanced, and is promoted by the renewable energy act (EEG). The strategy of the federal government is to promote biofuel production massively; this strategy justified with a decrease in import dependency and CO_2 reduction possibilities. Moving away from ambitious goals for biofuel quotas in 2020 (Federal Ministry for Nutrition, Agriculture and Consumer Protection

(BMELV), 2008), however, shows that the discussion about social and environmental problems has made a rethinking necessary.

While the fuel standard regulations concerning air pollutants were very successful (which is validated by the EU fuel quality monitoring: EC, 2010), the biofuel policy of the federal government, which made Germany use biofuels even more than required by EU law, is under critique. It can be seen as "greenwashing", since the necessary certification is not sufficient to ensure socially just and environmentally friendly biofuel production. It is, therefore, necessary to exploit the most efficient use of local biomass and to lower biomass imports from non-EU countries until efficient certification is in place.

Although the German Federal Government very successfully promoted the use of biofuels, the environmental impact of this policy may not be as positive.

In general, the use of subsidies for the promotion of sustainable mobility in Germany is not very efficient; billions of euros are spent inefficiently for uncertain future technologies (electric mobility), public transportation or to please the car industry with the environmentally semi-successful scrapping premium. The promotion of biofuels is very successful, but its environmental impact is discussed very controversially.
Hence, the use of subsidies is rated with **5/10.**

Concerning the removal of harmful subsidies, only few efforts of the German Federal Government could be found.

7.2.6 Removal of Harmful Subsidies

In this chapter, an evaluation of the German Federal Government concerning the removal of environmentally harmful subsidies (mainly for road transport) is performed.

Tax Reliefs for Diesel Fuel

The tax reliefs for diesel fuels amount to 6.15 billion euros per year and are, consequently, a massive subsidy for the purchase of these cars. The subsidy is justified by the fact that diesel vehicles consume less fuel than gasoline fuels. Still, they are also less energy-efficient and because of the subsidy, the engine power of diesel cars has increased so much, that the average diesel car emits more CO_2 than the average gasoline car (Zeit, 2011). A new EU regulation has tried to force the German government to equal diesel and gasoline taxation, which the German Federal Government rejected vehemently.

Commuter Subsidy

The commuter subsidy is – as shown in chapter 5 -, one of the most harmful indirect subsidies for the use of private cars and urban sprawl. Additionally, it is socially unjust, as it favors people of high income (UBA, 2004). Environmental organizations advocate the removal of this subsidy for a long time, but neither the red-green nor the black-red or the black-yellow government has decided to do so. A small modification was proposed in 2007 (the elimination of the subsidy below distances of 21 km), but the Federal Court forced the Federal Government to either remove the subsidy completely or to leave it for all distances. The Federal Government,

therefore, did not attempt to remove this subsidy and is not considering it presently either.

Flat Tax on the Private Use of Company Cars

The flat tax on the private use of company cars is a direct subsidy for the purchase of energy-consuming company cars (more than 50% of the most consuming cars are company cars: Die Klima-Allianz, 2011a). It fulfills no obvious purpose other than to allow companies to buy expensive cars for their employees instead of raising their wages and to promote the German car industry further. The modification of removal of this subsidy, as environmental organizations and the German Environmental Office advocate it, is not considered.

Together with the fact that no effort is made to lower other hidden subsidies such as road construction and maintenance and other subsidies listed in chapter 5, the rating for the German Federal Government for the removal of harmful subsidies can be no higher than **1/10.** The conclusion of federal fiscal efforts for sustainable mobility cannot be very positive.

7.2.7 Conclusion

Massive amounts of money are spent each year by the German Federal Government for indirect subsidies both for private cars and for public transportation. However, while the (hidden) subsidies for private cars and the car industries very successfully enhance car usage, the subsidies for environmentally sound technologies and transport modes either are used inefficiently or are given for questionable technologies and fuels.

The taxation strategy was more successful, but also not consistent enough. Hence, the use of financial means for the promotion of sustainable transportation by the German Federal Government cannot be rated higher than **4/10.**

As the third measure category, the use of soft measures is analyzed.

7.3 Soft Measures

The evaluation of the effectiveness of the German Federal Government with regard to transport behavior is based on the criteria in chapter 1. Key questions are: Did the German Federal Government try to change the attitudes of transport participants and give them confidence to adopt sustainable transport patterns? Did they attempt to change social norms and influence the public opinion on transport? Were the (real and perceived) costs of alternative transport modes lowered and did the German Federal Government perform all necessary steps to a sustainable transport behavior change?

As described by Gilbert (2004), soft measures with the goal of behavior changes are very difficult to evaluate. Often, no effect is visible at all, but people may just have gone “one step further“ to behaving sustainably (compare the transtheoretical model in chapter 2). Another problem is the methodology of the evaluation. As it is in most cases too expensive to observe traffic change in a traffic survey, inhabitants of the region are interviewed in most cases (or general statistics like the number of participants are taken). Here, however, the problem of “socially desired answers“ occurs: People tend to give false information about their mobility

behavior when they feel the interviewer wants to hear "positive" information (in this case, a change in mobility behavior). Consequently, the effectiveness of measures is hard to evaluate; what can be rated, nevertheless, is the effort of the German Federal Government in implementing campaigns, starting with the promotion of non-motorized transport.

7.3.1 Promotion of Non-motorized Transport

"Kopf an – Motor aus" is not only the first and - up to now - only big federal project for the promotion of non-motorized transport modes, but is also very well evaluated. 76% of the citizens in the participating cities (projected number based on the sample) remembered the campaign and around 16% of the people indicated that they changed their mobility behavior. The projected modal shift from the car is specified with 35.3 million km to the bike and 22.9 million km to walking. The calculated CO_2 reductions amount to around 13.650 t CO_2, which would lead to relatively low abatement cost of 88€/ton (Wuppertal Institut, 2010).

With the "national bicycling plan" from 2002 to 2012, initiated by the red-green government, a number of measures for the promotion of bicycling traffic have been conducted. However, most of them are on local level and can hardly be evaluated. The research initiative "Rad-NKA", which deals with the evaluation of bicycling promotion projects, is, therefore, very sensible.

Another well evaluated projected (but only on the actor side) is the contest for communities for the establishment of bicycle renting systems. Many communities applied for a financial promotion of their concepts by the Federal Government. With much effort, concepts were compiled and assessed with respect to their implementability and effectiveness. As a result, this project is rated as very positive, as well. Sources: Raumkom (2011), Federal Ministry of Transport (2010), Fairkehr (2010).

In the framework of the national bicycling plan, a huge number of publications have been produced by scientists, policy makers and mobility participants. On the homepage http://www.nationaler-radverkehrsplan.de, documents for the promotion of bicycles, the construction of infrastructure, practical advices for the use of bicycles, funding possibilities for local communities, cost-benefit analyses of bicycling measures, and many more are available.

The project "pedestrian and bicycle-friendly cities" has been performed in three cities from 2001 to 2003 and was evaluated by the UBA (UBA, 2006). The campaign was recognized by 60% of the inhabitants. The evaluation of the quality of the bicycling infrastructure improved significantly from 2001 to 2003. However, the modal split of bicycling developed in very different ways in the three cities. In the two cities that successfully increased the modal split of bicycles (Lingen and Plauen), the cost-benefit ratio was only 0.19/0.89, which shows that the promotion of bicycling can indeed lower costs.

As UBA (2006) shows, image campaigns can (in connection with infrastructural measures) induce a significant modal shift (5 to 20% more walking and cycling in three model cities). Still, the results and the campaign as well as the material on the homepage is not publically

known: Without efficient marketing to the broad population, even the best measures and documents will stay worthless. The German Federal Government is quite active in promoting bicycling. In contrast, no similar plan exists for the promotion of walking, although it is the most important transport mode. Here, a big weakness in the transport concept of the German Federal Government can be diagnosed, as this transport mode almost plays no role in their considerations at all (Eid, 2011).

Overall (taking into consideration that the share of non-motorized transport modes stays constant and even slowly increases), the rating is **6/10**.
A worse rating has to be given to the promotion of public transport use.

7.3.2 Promotion of Public Transport

Westphal (2010) shows that marketing and communication can help in bringing people to use public transportation. However, no country wide or even regional big campaigns for the use of public transportation have been performed. Although many infrastructural problems for public transportation still exist (especially in rural areas), the most urgent problem of public transport in Germany is its bad image. Experiences show that information and communication measures can lead to a modal shift of 10% from the car to public transportation and walking / cycling for new residents of a city, for instance (Klima Kampagnen Baukasten, 2008). Another campaign showed that interactive communication measures (here called: dialogue marketing) successfully changed modal splits while "only" informational measures showed no success (Klima Kampagnen Baukasten, 2011).

The German Federal Government perceives the promotion of public transportation as the task of the local public transport providers. If projects are funded, the initiative for the project mostly comes from local initiatives (as in the example of "youthmove").

Except for the suggestion of quality standards for local transport providers (Difu, 2005), no Federal level projects for the promotion of public transport can be found. This is also due to the complicated shares of responsibilities within the Federal Government, the "Länder", communities and the different levels of transport providers. As the example of the "Patenticket" shows, (after which two thirds of the participating persons used public transport more often than before (TU Dortmund, 2011)), lot of potential exists (which are not exploited by the German Federal government). The promotion of public transport by the Federal Government (no assessment of local governments is included here), therefore, is only **3/10.**

Despite some pilot projects, similar can be said from the promotion of urban planning and mobility management.

7.3.3 Urban Planning and Mobility Management

Independent of the failure to ensure sustainable urban planning with "hard" measures (cf. chapters 7.1and 7.2), we now make an assessment of urban planning and mobility management with the help of "soft measures":

An important project is “effizient mobil“, which aims at the implementation of mobility management systems for companies and local communities. The program was estimated to have a reduction potential of 133 Million car kilometers or 23,000 tons CO_2 (Dena, 2011). Unfortunately, no concrete evaluation of the effectiveness of the implemented measures up to now has been carried out (Dena, 2011). The project is focused on a number of model regions, a mobility management on state- or federal level is not planned (Verkehrzeichen 3/10).

The project NAPOLI investigated the connections between urban structures and sustainable transportation in two cities, Leipzig and Münster and came to the conclusion that long-term projects for a dense urban structure in combination with a promotion of sustainable alternatives to car transportation are possible (ILS NRW, 2005), but often lack medium-term success.

The project RAVE also investigated the influence of city structure on mobility behavior in the example cities of Freiburg and the smaller city Viernheim and showed that big urban centers have an easier task in sustainable urban planning (TU Dortmund, 2004). An example for an innovative project for sustainable urban structure is “Wohnstandortinfo“. Here, information on residential areas for citizens that are about to move into a city, are given. Indeed, 38% of the participants moved into a suggested area (Klima Kampagnen Baukasten, 2010). The traffic effect, however, was small due to the small number of participants. The research project “Stadtleben“ about the mobility behavior in different districts of Cologne showed that city-core districts have a much higher share of sustainable transport modes and also a higher flexibility in their transport choices (Traffic Planning Faculty TU Dortmund, 2003).

Concerning the use of intelligent transport information systems, a study concludes that only motorways in Germany have sufficient information equipment while the use of these systems in urban areas and especially for public transport still is underdeveloped. As in other sectors, a clear priority towards MIT is visible here (Federal Ministry of Transport, 2004).

In general, many promising research projects and successful case studies for the implementation of soft measures for sustainable urban structures have been performed. Nevertheless, an implementation of these cost-effective measures on a federal basis has not been achieved in any of these cases. Consequently, the rating is **4/10.**
Next, the promotion of efficient driving behavior is analyzed.

7.3.4 Promotion of Efficient Driving Behavior

The strategy of the German Federal Government to use driving teachers as multipliers for fuel-efficient driving behavior is very sensible. However, as those measures have a limited impact, the Federal Government perceives driving behavior training for all car drivers as important (Autosieger, 2007). As often, technical measures such as gear change indicators are perceived as being the right way here. However, a binding eco-driving training for all car drivers (as, for example, offered by DVR, the German Traffic Safety Council) could help to reduce fuel consumption by 3-5% (and even up to 10%, Harmsen et al., 2003) and could be much less expensive than infrastructural or technical measures. The rating here is **5/10.**

Now, the promotion of new mobility and working concepts is analyzed.

7.3.5 New Mobility and Working Concepts

Car-sharing is an efficient way of reducing both transport activity and transport emissions: As research shows, car-sharing users have more sustainable transport patterns than "normal" car users and that the average car-sharing vehicle fleet is more efficient than the average German vehicle fleet (Green party of Germany, 2008). Although many decisions for the implementation of an efficient car-sharing system are taken from local governments and companies, a general framework for the implementation of car-sharing as a mobility concept (similar to taxis) has to be taken. Still, the German Economic Ministry blocks this guideline (ibid.). A federal promotion of car sharing has not taken place up to now, although it was advocated since as early as 1998 (Green parliamentary party, 1998). Car sharing in Germany is progressing nevertheless (Autobild, 2011), but this is not due the influence of the German Federal Government.

Alternative working concepts are not only family friendly and important for the work-life balance but can help reducing traffic (compare chapter 5). Although the legal possibilities are in many cases given (Best-Zeit, 2002), the German Federal Government does not promote concepts like teleworking, compressed working times etc., although these measures could even decrease external costs for the federal government by lowering traffic volume and congestion. The recently started campaign for family-friendly working times is good, but it can be doubted that traffic is reduced by this measure (the traffic advantage of part-time jobs could be eliminated by separated working times with more transportation demand).

Teleworking possibilities are sparely used in Germany in comparison to other countries (IEA, 2009a), also as a consequence of insufficient promotion. As a conclusion, it must be stated that alternative working and mobility concepts do not seem very popular within the Federal Government; their promotion is rated with **2/10.**
No analysis was performed concerning other public awareness programs.

7.3.6 Other Public Awareness Programs

Unfortunately, no evaluation about the effectiveness of "Kurz-nah-weg" could be found, although the idea of the campaign is perceived as being very good. The campaign "Für dich, für mich, fürs Klima", which ended in 2010, was initiated by consumer protection organization. An evaluation of the measures could not be found, either. Regardless, the goal of 1.5 to 2 million tons of CO_2 that should have been saved with the campaigns seems extremely ambitious.

7.3.7 Conclusion

As can be seen from the measures above and throughout the whole thesis, the German Federal Government does not focus on a behavior change in transportation. No attempts have been made to change the existing social paradigms of transportation (which are mainly focused on

the private car); strategies and support for behavioral changes towards sustainable transportation have been offered only very sparsely.

In general, soft measures for sustainable mobility are not very popular with the German Federal Government, which seems to be extremely focused on technical measures without the need for behavioral changes. Although many pilot projects have been performed, no implementation of these projects on federal level is aspired to. In addition, well-known and evaluated measures, such as driving behavior trainings, are not considered necessary. The implementation of alternative working and mobility concepts are not consequently promoted. As a positive point, the implementation of the first project for the promotion of non-motorized transport modes "Kopf an. Motor aus" can be seen, although at 1.2 Million € its budget is with only 0.1% of the promotion of electric mobility, for instance. As total rating, therefore, only **4/10** can be given.

As a second step after the analysis of measures in different categories, the policy packaging of the German Federal Government is evaluated.

7.4 Policy Packaging

The German Federal Government created the following political packages for establishing sustainable transportation:

Political package I (German Federal Government, 2002)

- Traffic avoidance (urban planning, lowering of area consumption, expansion of infrastructure rather than new construction)
- Modal shift (Promotion of non-motorized transport and public transport, market based instruments)
- Investments in infrastructure (all transport modes)
- Interconnection of transport modes
- Lowering of environmental harm, security improvements (increased fuel taxes, alternative fuels and propulsions, labeling, promotion of eco-driving)
- Promotion of mobility research (use of ICT technologies for traffic avoidance)
- International cooperation (removal of environmentally harmful subsidies, new emission standards for passenger cars, concepts for emission standards for railway vehicles).

This political package can be rated as very good, since it includes avoid, shift and improve measures at the same time. The removal of environmentally harmful subsidies combined with a promotion of public transport alternatives as well as the combination of increased fuel taxes and the promotion of eco-driving makes a lot of sense. However, this package was only a declaration of intent and the measures have never been implemented at the same time. Instead, the two latest political packages of the German Federal Government indicate bad packaging planning:

Political package I1 (Federal Government of Germany, 2010)

- Promotion of innovative propulsion technologies such as electrical mobility and fuel cell vehicles
- Further expansion of biofuels
- Labeling for car fuel consumption
- Promotion of a legally binding CO_2 threshold for passenger cars (only at EU level)
- Basing the car taxation on CO_2 emissions.

Independent of doubts concerning the effectiveness of measures such as the promotion of biofuels or electric mobility, the policy package of 2010 can be rated as rather ineffective, compared to the criteria set up in chapter 6: Traffic avoidance and modal shift measures are not listed here at all. Instead, a number of different measures for fuel and vehicle emissions are announced. While this is a very valuable goal, all these measures aim for the same reduction category and lower their cumulative impact. The most current political package is slightly better, but still lacks in important parts:

Political package III (sustainability report of the German Federal Ministry of Transport, 2011)

- Promotion of innovative propulsion technologies such as electrical mobility and fuel cell vehicles and further development of conventional engines
- Promotion of biofuels
- Expansion of traffic management systems
- Stronger competition for public transport
- Strong focus on electric mobility
- Promotion of bicycling with the implementation of measures in the framework of the "National Cycling Program 2002 to 2012"
- Prioritize further expansion of (road) infrastructure based on the highest economic feasibility
- Active promotion of mobility.

Again, no traffic avoidance efforts are being proposed. Instead, mobility is actively promoted, which fits into the current development, that effectiveness increases are counterbalanced by increasing traffic activity (cf. chapter 7.5). While stronger competition for public transport in general is good, simultaneous road expansion also counterbalances possible quality improvements for PT. The promotion of bicycling is weak, the "National Cycling Program 2002-2012" soon will be over and no additional efforts for bicycling (and no efforts at all for walking) are being made. The category "improve" is mainly based on biofuels, some (rather weak) labeling efforts and the promotion of electric mobility. No effort for the "downsizing" of engine power is made.

It must be concluded that the German policy packages are very one-sided and mainly based

on very vague and questionable measures for lowering the number and of use of passenger cars. Measures for modal shift can be rated as rather weak while traffic avoidance does not play a central role in current packages; instead, an increasing traffic is actively promoted with the construction of new infrastructure. In conclusion, the political packaging in Germany is rated with **4/10**.

The last step is based on indicators for the sustainability state of the German transport sector and their development, compared to some goals set by the German Federal Government.

7.5 Indicator-based Evaluation

Based on the development of some key indicators (trend color-coded) and a comparison of their development with the proclaimed goals of the German Federal Government, a quantitative analysis of the performance of the work of the German Federal Government is performed. Although the German Federal Government is not fully responsible for the development of these indicators, it has the possibility to influence all of them and can be made responsible for the state of sustainability of the German transport sector to a large extent, therefore.

Indicator	Goal	1990	2000	2010	Trend	Goal	Source
Total transport GHG emissions (1000 tons, CO_2-equivalent)		163,881	186,337	153,304 (2009)			(UBA, 2011c)
Total road transport GHG emissions (1000 tons, CO_2-equivalent)	-5% road transport emissions from 1998-2005	152,238	173,053	145,686 (2009)			(UBA, 2011b), (UBA, 2011c)
Total transport CO emissions (1000 tons)	*	6624.33	2523.48	1187.2 (2009)			(UBA, 2011c)
Total transport NOx emissions (1000 tons)	*	1494.5	1099.19	614.11 (2009)			(UBA, 2011c)
Total transport NMVOC emissions (1000 tons)	*	1434.09	291.55	122.74 (2009)			(UBA, 2011c)
Total transport SO_2 emissions (1000 tons)	*	105.25	21.40	1.56 (2009)			(UBA, 2011c)
Total transport PM 10 / PM 2.5 emissions (1000 tons)		64.43 (1995)	55.02	34.63			(UBA, 2011c)
Energy consumption of the transport sector (TWh)	- 10% / -40% by 2020 / 2050 compared to 2005	661 (1995)	718 (2005)	705 (2009)			(UBA, 2011e)

Indicator	Goal	1990	2000	2010	Trend	Goal	Source
Number of road vehicles (Mio.)		44.9	53.1	57 (2011)			(UBA, 2009e), (KBA, 2011a)
Number of electric cars	1 Million by 2020, 6 Million by 2030			Around 4,000			(KBA - German Agency for Motorized Vehicles, 2011)
Emissions of new vehicles (g/km)	137 g/km by 2015, 95 g/km by 2020	197 (1995)	182 (2000)	151.2 (2010)			(Donaukurier, 2011), (German Environmental Ministry, 2008)
Fuel consumption of new cars (l/100 km)	-25% / -33% by 2005 / 2010 compared to 1998	9.2 (1991)	8.3	7.5 (2008)			(UBA, 2009d)
Total transport demand (Billion pkm)		874.7 (1991)	1045	1064.9 (2009)			(UBA, 2009c), (Federal Statistical Office, 2011)
Modal split (pkm), motorized modes (cars / PT / aviation)		81.6 / 15.8 / 2.6	81.3 / 14.6 / 4.1	79.6 / 14.9 / 5.6 (2008)			(UBA, 2009c)
Modal split (pkm), including non-motorized transport (cars / PT / cycling / walking / aviation)	Increase of bicycling modal share (from 2002 to 2012)	76.2 / 15.4 / 2.5 / 3.1 / 2.7 (1992)		75.4 / 13.7 / 2.6 / 3.3 / 5.0 (2007)			(UBA, 2009b)
Modal split (ways) land transport (cars / PT / cycling / walking)	Increase of bicycling modal share (from 2002 to 2012)	59 / 10 / 8 / 22 (1998)	61 / 9 / 9 / 22 (2002)	59 / 9 / 10 / 23 (2008)			(Federal Statistical Office, 2011), (Infas / DLR, 2008)

Indicator	Goal	1990	2000	2010	Trend	Goal	Source
New passenger car engine power (PS)		95.1 (1995)	110.4	134.4 (2011)			(Ruhkamp, 2011)
Transport intensity (pkm/GDP)	-20% by 2020 (compared to 1999)			-9.1% compared to 1999 (2008)			(UBA, 2010g)
Land use (ha/d)	Decrease to 30 ha/d for residential and transport purposes by 2020	120 (1992-1996)	129	78 (2009)			(UBA, 2009a)
Biofuel quota	6.25% share,			7%			

Table 5: Sustainability indicators of the German transport system

*= No specific emission goals for transportation exist. The goals for overall emissions according to the Gothenburg Protocol, however, have been achieved widely.

The emission of air pollutants has been successfully reduced; still, the German Federal Government has only very limited responsibility for this success as the emission thresholds were assigned by the European Union. Another small success is the (slow) reduction of the total CO_2 emission in the transport sector in Germany. This has mainly been due to efficiency improvements of passenger cars; other key indicators, such as the modal split or the total transport demand, however, show a negative development. The goals of the federal government (which mostly only refer to efficiency improvements), have in some cases been achieved, but in most cases, the (projected) development is rather negative. The quantitative, indicator-based rating of the effectiveness of the German Federal Government concerning the sustainability of the German transport sector is evaluated with **5/10,** therefore,

In the next chapter, the evaluation of the German policy will be concluded and suggestions for policy improvements are given.

8. Evaluation of the Federal German policy

In chapter 7 , different assessments of the effectiveness of the German Federal Government have been performed and they all show a similar picture:

- Regulation (mainly qualitative): **6/10**
- Fiscal measures (mainly qualitative): **4/10**
- Soft measures(mainly qualitative): **4/10**
- Policy packages (qualitative): **4/10**
- Indicator development (quantitative): **5/10.**

If a weight of 20% for regulation, fiscal measures and soft measures, a slightly higher importance of 30% for the indicator development and a weight of 10% for the evaluation of policy packaging is set, the total rating of the German Federal Government is **4.7/10.**

The German Federal Government has "earned" this relatively bad rating because its effort to make transportation more sustainable are very half-hearted and one-sided: Large efforts and funds are invested into the development of new mobility technologies such as electric mobility. While new technologies for more environmental vehicles are important, the provision of better public transport options, and behavioral mobility changes could produce the same positive effect for less money and in a shorter period. However, the German Federal Government seems to follow the premise "environmentally sound transport without behavioral change", which is not likely to work, as shown in chapter 2, and is in any case the more expensive and insecure option. It appears to be very important for the federal government to prevent any harm to the German car manufacturers (which indeed are economically very important in Germany) by allowing them to keep their market with new vehicle technologies. However, even if road transportation could be provided without the emission of any harmful substances, the problems of noise, accidents, sealing of soils and congestion would persist (Monheim, 2011). The German Federal Government still focuses its efforts for transportation almost entirely on the provision of convenient road transport (an example: All building owners have to provide financial means for parking spots and road construction, Monheim, 2011). In a further budget increase for transport infrastructure, the additional means have been shared with 5:1:2 between road, rail and waterways (TAZ, 2011). The Nature and Biodiversity Conservation Union Germany (NABU) published a list with environmentally harmful road construction projects with a budget of 30 billion euros (NABU, 2010). In comparison, the annual budget for railway infrastructure projects is around 4.5 billion Euros (Allianz pro Schiene, 2010).

Instead of creating broader coverage of public transportation, as it has successfully been done in Switzerland (Monheim, 2011), the German local railway network was systematically thinned out. Expensive prestige projects such as the high-speed train ICE are more important than the creation of a broad basis for sustainable urban transport.

The fear that "real" efforts for sustainable transportation harm the German economy is un-

substantiated: A study of the German Environmental Agency and the Wuppertal Institute shows that no economic harm can be expected if efforts for behavioral change are undertaken (UBA, 2001).

The German Federal Government did not follow the recommendation of Otto (2010), to combine soft and hard measures for maximum efficiency, but rather focusses on hard measures alone. From the soft measures suggested in Table 3, only the traffic-reducing urban planning has been (more or less) implemented. Psychological models for behavior change do not play a role in the German policy for sustainable transportation, although behavioral changes are essential for making transportation in Germany more sustainable.

By prioritizing the development of public transport and the promotion of non-motorized transport (especially walking is presently neglected in the transport strategy of the German Federal Government: (Eid, 2011)) and the consideration of the importance of psychological factors for sustainable mobility, the satisfaction with the transport system in Germany could be significantly improved.

Suggestions for an improvement of the sustainability of the German transport system and the effectiveness of the measures of the German Federal Government are:

- A harmonization of the fragmented system of public transport providers with a unified and affordable pricing system, e.g. introduction of a "citizens ticket", a price-reduced ticket for the flat use of all public transport systems in a region (more details: Cavelius, 2011).
- The transition of urban planning from a car-focused approach to the promotion of public transport and non-motorized transport modes (NABU, 2005).
- The removal or reduction of environmentally harmful subsidies such as commuter subsidies or the flat tax on the private use of company cars (details: BUND, 2004, Die Klima-Allianz, 2011a). The saved money could be used to improve the quality of public transport service. Public transport promotion should be connected with quality criteria; private competition should be gradually introduced.
- The introduction of company mobility concepts and mobility centers, as implemented in the Netherlands (Monheim, 2011).
- Promoting new mobility concepts such as car sharing and carpooling.
- Transforming the Federal Transport Infrastructure Plan into a tool for the establishing of sustainable transport infrastructure rather than a tool for a further expansion of the road network (NABU, 2005; Monheim, 2011). The German public transport strategy should focus on providing transportation for both rural and urban areas, instead of implementing expensive flagship projects. Positively evaluated and successful projects such as bus systems and rural trams should be expanded (Monheim, 2011).
- The implementation of public awareness campaigns and other promotional measures for the use of public transport and non-motorized transport modes (more details: UBA, 2006, Gilbert, 2004). The social norm with the preference of the private car should be changed by public statements, role models and awareness campaigns.
- Considering non-motorized transport modes in the national transport strategy.

- Legal measures (e.g. establishing of quotas) for the protection of soils and against further area fragmentation (UBA, 2010d).
- The internalization of the external costs of transportation (mainly road transport) by the introduction of Pigouvian taxes, for example higher fuel taxes and (local and national) road taxation systems.
- The Promotion of regional economic cycles, for instance by promoting companies that use local products and raw materials (more details: UBA, 2003b).
- Introducing a speed limit for the German motorways.
- The implementation and further aggravation of legally binding emission limits for car manufacturers operating in the German market (in coordination with the EU), consideration of cap-and-trade systems for transport related greenhouse gas emissions.
- The creation of self-enhancing policy packages for sustainable mobility in cooperation with the German states and communities. Hard or "push" measures should be complemented by appropriate soft or "pull" measures.
- A cost-benefit assessment of measures (including "soft measures") for the promotion of sustainable mobility and the implementation of most economic measures.

By introducing these (partly very cost-efficient) measures, the sustainability of the German transport system could be significantly improved.

Despite this pessimistic conclusion, many indicators in Germany (like the development of energy efficiency and the slowly growing modal share of environmentally friendly transport modes) point toward the right direction. The biggest problem remains the ever-growing transport demand. However, the famous transport researcher Lee Schipper, how died in August 2011, devoted one of his last papers to the conclusion: "Peak travel" is possible (Millard-Ball & Schipper, 2010).

9. Annex

Policies for sustainable transportation

Instrument	Further description	Impact category (A, S, I)	Measure category (Regulation, Economic, Soft measure)	Estimated mitigation potential in Mio t CO_2 (overall emissions transport sector: 152 Million tons)	Implementation cost	Covered here?	Priority (1=low, 5 = high)
Emission standards for motorized vehicles	Emission thresholds	I	R	3.4-5 (2030, cars), 0.3 (2020, trains)	low	X	**5**
Alternative fuel, fuel quality norms	Biofuels, hydrogen, other innovative fuels	I	R, E	0.3-6.2 (different biofuels), hydrogen and other fuels hardly assessable	medium - high, 100-600€/t CO_2 saved	X	**2**
Speed limit, Traffic calming	General speed limit on motorways, urban traffic calming	A, S, I	R, S	2.9-3.2 (Speed limit 120 km/h, 3-5% fuel reduction), no general CO_2 reduction for traffic calming in cities	medium, around 11 $/barrel oil saved	X, but mainly local	**5**
Environmental zones, driving bans	Temporary driving bans, zones with higher emission standards	A, S	R	Positive and negative effects for env. Zones, 1.7-9% (2.6-13.7 Mio. t) for different driving bans methods	low, 0.32-5$/barrel oil saved	X, but mainly local	**3**
Fuel rationing	Set limit for fuel use	A, S, I	R	8.5% fuel reduction (around 13 Mio.t)	low	not feasible	**-**
Contingents for fuel consuming vehicles (e.g. SUVs)		I	R	high	low	not realizable	**5**

Instrument	Further description	Impact category (A, S, I)	Measure category (Regulation, Economic, Soft measure)	Estimated mitigation potential in Mio t CO_2 (overall emissions transport sector: 152 Million tons)	Implementation cost	Covered here?	Priority (1=low, 5 = high)
Urban development & Land use planning	Traffic avoiding urban planning, car-free housing etc.	A, S, I	R, E, S	very high (10-15% or 15-23 Mio. t), other estimations up to 13.8 Mio t savings	medium	X, partly local	**4**
Technical improvements, new technologies	Technological vehicle improvements, new vehicle concepts (electric mobility)	I	R, E	very high (13 Mio t alone for fuel saving oil and tires), overall: 55 Mio t	very low - very high	Yes, but not in focus	**1-5**
Downsizing	Lowering car engine power	I	R, E, S	2.3	low (90-360 €/t)	No	**5**
Car sharing / Occupancy rate increasing	Car sharing and ride-matching / carpooling concepts, better occupancy of public transport	S, I	S	very high (22% reduction or 33.4 Mio t for one person more per car), 3.2 (Ride matching, realistic), car sharing potential hard to estimate, up to 10% reduction (15.2 Mio t) possible	Dependent on measure, 1$/barrel for information campaign, up to 4000$/barrel for construction of car-pooling lanes	partly	**4**
Promotion of non-motorized transport	Infrastructure, prioritization, image campaigns	S	R, E, S	4-13 in different scenarios, other source: 4% (6 Mio. t)	very low (image campaigns) - high (infrastructure)	X, but mainly local	**4**
Promotion of public transport	Infrastructure, prioritization, image campaigns	S	R, E	5.1	very low (image campaigns) - very high (infra-	X, partly local	**4**

Instrument	Further description	Impact category (A, S, I)	Measure category (Regulation, Economic, Soft measure)	Estimated mitigation potential in Mio t CO_2 (overall emissions transport sector: 152 Million tons)	Implementation cost	Covered here?	Priority (1=low, 5 = high)
					structure)		
Reduce road infrastructure construction	Stop traffic inducing road construction	A, S	R	2.3	negative, money is saved	X	**5**
Alternative working concepts	Teleworking, compressed week, etc.	A	E, S	6-7% (9-10.6 Mio. t)	very low (0.5$/Barrel, economic effects unknown)	no	**2**
Car taxation		A, S, I	E	4.2	low, measure already implemented	X	**3**
Elimination of (hidden) subsidies	Internalization of external costs, elimination of tax reliefs for commuters and company cars, etc.	A, S, I	R, E	4.9 (commuter subsidy), 2.8 (flat tax on private use of company cars), 5.7 in total	negative, money is saved (up to 6 billion€ annually for the commuter subsidy alone, despite of negative economic effects)	X	**4**
Fuel taxation		A, S, I	E	17.9	low costs	X	**3**
Parking management	Parking pricing, parking spot reduction,…	A, S	R, E	0.5-4% reduction (0.8-6 Mio. t) possible	zero to low costs	No, local responsibility	**4**
Road taxation	Taxation for motorways	A, S, (I)	E	3-4% (4.5-6 Mio. t)	dependent on system, negative economic effects?	X	**3**
Further subsidies for public transport	Lower taxes for public transport, reduce transit	S	R, E	Disputed potential for fare reduction (4-6% more trips for 10% reduction: OECD, no significant reduction:	High (500$/barrel for fare reduction)	X, partly local	**3**

Instrument	Further description	Impact category (A, S, I)	Measure category (Regulation, Economic, Soft measure)	Estimated mitigation potential in Mio t CO_2 (overall emissions transport sector: 152 Million tons)	Implementation cost	Covered here?	Priority (1=low, 5 = high)
	fares			Prognos), 1.3 Mio t savings for lower tax on trains and higher taxes on aviation			
Promotion of regional economic cycles		A	R, E, S	3.2	dependent on measure type	X	**2**
Emission trading	Inclusion of transportation in emission trading system	A, S, I	E	Hardly quantifiable	dependent on measure, from additional income to medium costs	X	**3**
Mobility & Information management	ICT use, better information, traffic management	A, S, I	S	ICT potential 10% (15 Mio t.), mobility management potential 1-5% (1.5-7.5 Mio. t)	medium-high	partly	**4**
Information and image campaigns		A, S, I	S	2% (3 Mio. t) (Prognos), single campaigns can achieve 10-20% reduction	very low	X, partly local	**5**
Labeling	Better labeling car consumption	S, I	R, S	6.7	very low	X	**5**
Eco-driving trainings		I	S	3.7	very low	X	**5**

Table 6: Evaluation of different measures for sustainable mobility

Sources: (UBA, 2010), (Die Klima-Allianz, 2011), (McKinsey, 2007), (Wuppertal Institut / DLR / IFEU, 2006), (Prognos, 2004), (IEA, 2005), (BMVBS, 2002), (GWS, 2004), (UBA, 2004), (Oeko / DLR, 2009

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